State of California
The Resources Agency
Department of Water Resources

FEDERAL ENERGY REGULATORY COMMISSION
LICENSE PROJECT NO. 2100

INITIAL INFORMATION PACKAGE

RELICENSING OF THE OROVILLE FACILITIES

January, 2001

Gray Davis
Governor

Mary D. Nichols
Secretary for Resources
The Resources Agency

Thomas M. Hannigan
Director
Department of Water Resources

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

EXECUTIVE SUMMARY

INTRODUCTION

The California Department of Water Resources (DWR) is the owner and operator of the Oroville Facilities[1], a multipurpose water supply, flood control, power generation, recreation, fish and wildlife, and salinity control project. The facilities operate under a license from the Federal Energy Regulatory Commission (FERC, or the Commission). The license for the facilities expires on January 31, 2007. Pursuant to the Federal Power Act, DWR is required to file an application for a new license (relicense) on or before January 31, 2005.

This document is an Initial Information Package (IIP) and was prepared to provide information about the facilities and their operation, the environment affected by the project, and resource issues and potential studies for the preparation of the license application. DWR has submitted a request to the FERC to use the Alternative Licensing Procedures (ALP) in relicensing the Oroville Facilities. The Commission approved DWR's request on January 11, 2001. The ALP enables the relicensing participants to tailor the relicensing process to address specific issues and streamline procedural compliance with multiple federal and state laws. DWR plans to develop an Applicant Prepared Environmental Assessment (APEA) to meet the requirements of the National Environmental Policy Act (NEPA), FERC's relicensing regulations, and the California Environment Quality Act (CEQA).

DWR is proposing a three-tiered process to achieve consensus on relicensing. The three tiers include a Plenary Group, Work Groups, and Task Forces. For those not interested in actively participating in the relicensing process, several options are available for staying involved, including review of DWR's website (http://orovillerelicensing.water.ca.gov), providing comments via a toll free number (866-820-8198) or e-mail address (orovillep2100@water.ca.gov), or reviewing DWR's quarterly newsletter. Public comments will also be solicited during the process. (See Figure 1-2 for the draft relicensing schedule.)

[1] For purposes of this document, the term "Oroville Facilities," refers to elements of the State Water Project, Oroville Division, identified in Federal Energy Regulatory Commission License Project No. 2100.

PROJECT DESCRIPTION

The Oroville Facilities are located on the Feather River in the foothills of the Sierra Nevada in Butte County, California (see Figure 1-1). The Oroville Facilities encompass 41,100 acres within the project boundary and include Lake Oroville (the state's second largest reservoir), Oroville Dam, three powerplants (Edward Hyatt Powerplant, Thermalito Diversion Dam Powerplant, and Thermalito Pumping-Generating Plant), Thermalito Diversion Dam, the Feather River Fish Hatchery and Fish Barrier Dam, Thermalito Power Canal, Thermalito Forebay and Forebay Dam, and the Thermalito Afterbay and Afterbay Dam, as well as a number of recreational facilities (see Figure 2-1). The 770-foot high Oroville Dam is the highest earthfill dam in the United States. The Dam is five miles east of the City of Oroville and about 130 miles northeast of San Francisco. The Dam, along with two small saddle dams, impounds Lake Oroville, a 3.5 million–acre-feet (maf) capacity storage reservoir with a surface area of 15,810 acres at its normal maximum operating level.

Located at Oroville Dam, the Edward Hyatt Powerplant is the largest of the three powerplants with a capacity of 645 MW. Water from the six-unit underground powerplant (three conventional generating and three pumping-generating units) is discharged through two tunnels into the Feather River just downstream from Oroville Dam. Four miles downstream of the Oroville Dam is the Thermalito Diversion Dam, which creates a tailwater pool for the Edward Hyatt Powerplant and is used to divert water to the Thermalito Power Canal. The Thermalito Diversion Dam Powerplant is a three MW powerplant located on the left abutment of the Diversion Dam. The powerplant releases a maximum of 615 cubic feet per second (cfs) of water to the river. The Power Canal is a 10,000 foot-long canal designed to convey both generating flows of 16,900 cfs to the Thermalito Forebay and pumping flows of 9,000 cfs to the Edward Hyatt Powerplant. The Thermalito Forebay is an off-stream regulating reservoir for the 114 MW Thermalito Pumping-Generating Plant. The Thermalito Pumping-Generating Plant has a generating and pumping capacity of 17,400 cfs and 9,120 cfs, respectively. When in generating mode, the Thermalito Pumping-Generating Plant discharges into the Thermalito Afterbay, which is contained by a 42,000 foot-long earthfill dam. The Afterbay is used to release water into the Feather River downstream from the Oroville Facilities, serves as a warming basin for agricultural water, helps regulate the power system, provides storage for pump-back operations, and provides recreational opportunities. Several local irrigation districts also divert water from the Afterbay.

The Feather River Fish Barrier Dam is downstream of the Thermalito Diversion Dam and immediately upstream of the Feather River Fish Hatchery. The flow over the dam maintains fish habitat in the low flow channel of the Feather River between the dam and the Afterbay Outlet, and provides attraction flow for the hatchery. The hatchery compensates for spawning grounds lost to returning salmon and steelhead trout from the construction of Oroville Dam. The hatchery can accommodate an average of 8,000 adult fish annually.

PROJECT OPERATION

The DWR stores winter and spring runoff in Lake Oroville for release to the Feather River, as necessary for project purposes (water supply, power generation, flood protection, fish and wildlife enhancement, and recreation). Typically, power is generated when water releases are being made for these other purposes, when deliveries are being made to local irrigation districts through the Afterbay, or when pump-back operations are in effect. Annual operations planning is conducted for multi-year carry over, in which half the Lake Oroville storage above the minimum pool is assumed available for subsequent years. The operations plan is updated regularly to reflect changes in hydrology and downstream operations. Typically, Lake Oroville is filled to its maximum annual level of up to 900 feet mean sea level (msl) in June and then can be lowered as necessary to meet downstream requirements, to its minimum level in December or January. During drier years, the lake may be drawn down more and may not fill to the desired levels the following spring. During 1991, 1992, and 1993, the minimum elevations were 651 feet, 702 feet, and 723 feet, respectively. During wetter conditions, Lake Oroville is managed to control downstream flooding. The U.S. Army Corps of Engineers (USACE) requires Lake Oroville to be operated to maintain up to 750,000 acre-feet (AF) of storage to capture significant inflows for flood control. Historically, the maximum flood flows released from Lake Oroville were 167,000 cfs in 1997.

On a weekly basis, releases are scheduled to accommodate water supply requirements, water quality and quantity requirements in the Sacramento-San Joaquin Delta, instream flow requirements in the Feather River, power requirements, and minimum flood control space. The weekly plan is updated as needed to respond to changing conditions. The Thermalito Dam Pool and the Thermalito Forebay and Afterbay are too small for seasonal storage so they are used only in weekly and daily operations planning. Hourly releases through the Edward Hyatt and Thermalito Pumping-Generating plants are scheduled on an hourly basis to maximize the amount of energy produced when power values are highest. Because the downstream water supply is not dependent on hourly releases and pumping of State Water Project (SWP) water can be scheduled at off-peak times, hourly operations are primarily dictated by electrical energy prices and ancillary service requirements such as spinning reserve, the supplemental energy market, and voltage regulation. Storage in the Thermalito Forebay and Afterbay is used to maximize the value of project energy and maintain uniform flows in the Feather River downstream of the Oroville Facilities. The Thermalito Afterbay also provides storage for pump-back operations. The pump-back operations are designed to use water in excess of what is required for downstream flow requirements for pumping back into the Thermalito Forebay and then into Lake Oroville in off-peak energy hours for re-release during peak hours when power rates again increase. Because the powerplants are operated to maximize weekday generation when power prices are highest, there is usually higher storage in the Afterbay by the end of the week. During the weekend, water from the Afterbay continues to be released to the Feather River, generation at the Hyatt/Thermalito plants is decreased, and pump back into Lake Oroville may occur. By the end of the weekend, the elevation of the Afterbay is lowered to prepare for a similar operation the following week.

Flows in the low flow channel just below the Thermalito Diversion Dam are maintained at a minimum of 600 cfs for fishery purposes, mainly by passing the flow through the 3-MW Thermalito Diversion Dam Powerplant. Flows in the Feather River are further augmented at the Thermalito Afterbay to meet downstream flow requirements and water supply needs. Generally, the downstream flow requirements are 1,700 cfs below Thermalito Afterbay from October to March, and 1,000 cfs from April to September. However, if runoff for the previous April through July period is less than 1,942,000 AF (i.e., the 1911-1960 mean unimpaired runoff near Oroville), the minimum flow can be reduced to 1,200 cfs. A maximum flow of 2,500 cfs is maintained from October 15 through November 30 to prevent spawning in overbank areas that might become de-watered.

In addition to flow requirements, the project is operated to meet water temperature objectives for the Feather River Fish Hatchery water supply and for the Feather River downstream of the Thermalito Afterbay Outlet. The hatchery objectives are 52°F for September, 51°F for October and November, 55°F for December through March, 51°F for April through May 15, 55°F for last half of May, 56°F for June 1-15, 60°F for June 16 through August 15, and 58°F for August 16-31. A temperature range of plus or minus 4F° is allowed for April through November objectives.

The objectives for the Feather River downriver of the Afterbay Outlet are a narrative. During the fall months, after September 15 the temperatures must be suitable for fall-run chinook. From May through August, they must be suitable for shad, striped bass, and other warmwater fish. Water temperatures are met through a shutter controlled intake gate system at the Oroville Dam that allows DWR to select water for release from various reservoir depths.

The water temperature objectives sometimes conflict with temperatures desired by agricultural diverters. Rice farmers desire water temperatures of 65°F from approximately April through mid-May, and 59°F during the remainder of the growing season. DWR is now trying to accommodate these needs by releasing water at the higher end of the temperature range required for the hatchery.

DWR is not proposing operational changes at this time, but changes may be implemented as a result of the relicensing process.

AFFECTED ENVIRONMENT

Feather River Watershed

The Oroville Facilities, located on the Feather River, a major tributary to the Sacramento River (see Figure 4-1), provide about 25 percent of the flow in the Sacramento River as measured at Oroville Dam. The Feather River watershed is approximately 3,600 square miles at Oroville Dam. The upper portion of the watershed is rugged and mountainous, while the central third consists of broad alluvial valleys separated by high, steep peaks and ridges. The eastern third consists of long broad meadow systems separated by relatively low ridges.

The North, South, and Middle Forks of the Feather River are the primary tributaries to the reservoir. About half of the flow into the reservoir comes from the North Fork. Two major tributaries join the Feather River downstream of the project. The Yuba River enters the Feather River 39 river miles downstream of Oroville, and the confluence with the Bear River is 16 miles farther downstream. The Feather River joins the Sacramento River about 67 miles downstream of Oroville.

Water Quantity and Use

The average annual unimpaired flow of the Feather River at Oroville is 5,800 cfs (4.2 maf). Much of the runoff occurs in the January through June period. Summer inflows are sustained at about 1,000 cfs because of snowmelt and groundwater inflow from the high-elevation watersheds. Due to several small diversions upstream, actual inflow into Lake Oroville is about 4.0 maf. Annual flows are variable and depend upon annual precipitation. From 1979 to 1999, annual inflows have ranged from a minimum of 1.7 maf to as high as 10 maf. Outflow from the project typically varies from spring seasonal highs to about 3,500 cfs in November. Although the Edward Hyatt and Thermalito Pumping-Generating Plants operate in a peaking mode, flows in the Feather River are held relatively constant via the Thermalito Afterbay Outlet works.

Monthly irrigation diversions of up to 150,000 AF are now made from the Thermalito Complex during the May through August irrigation season. Annual diversions are slightly less than 1 maf, leaving about 3 maf for flow in the Feather River downstream of the project. Discharges into the lower Feather River continue into the Sacramento River and into the Sacramento-San Joaquin Delta. At the north end of the Delta, the water is pumped into the North Bay Aqueduct. In the south Delta, water is diverted into Clifton Court Forebay where the water is stored until it is pumped into the California Aqueduct. Additionally, flows through the Delta are maintained to meet Bay-Delta water quality standards.

Geology and Soils

The Feather River watershed is comprised of a diversity of rock types: granitic, volcanic, metamorphic, and sedimentary. Under present land use conditions, many of the headwater streams in the watershed have formed sharp, V-shaped channels devoid of vegetation. These channels are easily eroded. In the lower two-thirds of the basin, flows are confined in deeply incised canyons with little or no floodplain. The floodplain downstream of Oroville Dam is covered by coarse debris from hydraulic mining and mounded remains of dredged tailings.

Historically, landslides have been a source of sediment to the river. Parts of the watershed produce high sediment yields, accelerated by human activity. However, the construction of Lake Almanor in 1913 and several Pacific Gas and Electric hydroelectric projects upstream of Lake Oroville has reduced sediment inflow to the lake. DWR estimates that about 18,000 AF of sediment has accumulated in Lake Oroville since its construction and has not significantly impacted its operation.

Sediment-free flow below the dam has scoured the river channel immediately downstream from the dam. The resulting substrate is armored by boulders and cobbles. This is particularly true in the low flow channel downstream of the Fish Barrier Dam. Farther downriver, the channel bed and banks become more variable as the river begins to flow through undisturbed older alluvium and floodplain deposits.

The seismicity at Oroville has been characterized as one of low-to-moderate magnitude earthquakes at relatively long recurrence intervals, occasionally resulting in minor ground rupture and offset.

Water Quality

Water quality data collected in the North, Middle, and South Forks of the Feather River indicate that dissolved oxygen (DO), pH, conductivity, temperature, and turbidity levels have generally been within established goals and criteria. There are a few exceptions to this. During the fall and early winter, conductivity in the Middle Fork has exceeded the Basin Plan Goal of 150 µmhos/cm. Turbidity has usually been low, but a water sample in 1996 produced turbidity values as high as 60 nephelometric turbidity units (NTU) in both the North and Middle Forks, and another sample in winter 1997 contained elevated levels of 35 NTU in the North Fork. The high turbidity levels were associated with high flows. In comparison to other water bodies, nutrients in the Feather River are at low levels. A few metals in the upper Feather River occasionally exceeded criteria for beneficial uses. These were: cadmium, which exceeded the National Toxics Rule (NTR) criterion in all three forks; total iron in the North and Middle Forks, which exceeded the agricultural goal in one sample in 1996; and lead from one sample in spring 1992, which exceeded the NTR and another in the South Fork in 1996. More recent analyses for arsenic have exceeded the NTR criteria in the North and Middle Forks.

Lake Oroville is typical of many other deep, steep-sided California foothill reservoirs with large surface fluctuations and a low surface-to-volume ratio. Water temperatures in Lake Oroville during the winter are generally uniform at about 45°F. Stratification begins in April and continues into the fall, with surface temperatures warming to a maximum of about 75°F in August. Water temperatures at the lower depths remain at about 50°F during the summer and gradually decrease through the fall.

Turbidity levels in the lake are typically low but can be high during the spring runoff period. During the spring, summer, and fall, turbidity levels are low near the surface. At deeper levels of 167 feet, turbidity levels as high as 22 NTU were measured. Dissolved oxygen, pH, conductivity, and metals concentrations are satisfactory and comply with Basin Plan Objectives developed to protect beneficial uses. Nutrients in the lake have generally been low, but total phosphorus concentrations were occasionally found at higher levels. MTBE, a gasoline additive, has been detected in the lake, but the concentration decreases rapidly after the boating season.

Water quality in the lower Feather River has generally been well within the goals of the Basin Plan for the protection of beneficial uses. Water temperatures are lower in the spring and summer than during pre-project flow conditions. Similarly, minimum annual water temperatures are higher than those experienced during pre-project conditions. Maximum water temperatures in the lower Feather River have been about 63°F. Nutrients and minerals in the lower Feather River are low. However, several metals have exceeded various criteria. Arsenic has exceeded U.S. Environmental Protection Agency (EPA) NTR criterion for continuous concentration. Cadmium and copper have also been found to occasionally exceed the NTR criterion for continuous concentration.

Water quality parameters in the Thermalito Forebay and Afterbay generally reflect the Lake Oroville parameters. Typically, daily water temperatures in the Afterbay since 1995 have been in the upper 50°F range.

Aquatic Resources

The reservoir and lower Feather River fisheries are regionally important for both coldwater and warmwater species. In Lake Oroville, the bass fishery is particularly important to the local economy as it supports bass tournaments almost every weekend. The Lake Oroville coldwater fishery is primarily comprised of chinook salmon and brown trout, although rainbow and lake trout are periodically caught. The coldwater fishery is sustained by hatchery stocking because natural recruitment in the lake is very low. This fishery is managed to produce trophy salmonids and to provide a quality fishery characterized by high salmonid catch rates. Chinook are the primary coldwater fish stocked in the lake, but brown trout are also stocked. Rainbow trout are no longer stocked partly because *Ceratomyxa shasta*, a myxozoan parasite lethal to most strains of rainbow trout, is prevalent in the lake. DWR and DFG are also reviewing the salmonid stocking plan to determine what, if any, adjustments might be made to address other disease concerns in Lake Oroville and the Feather River Fish Hatchery.

The warmwater fishery is comprised of four species of black bass, two species of catfish, two species of sunfish, and two species of crappie. Spotted and largemouth bass are the most prevalent. Because of the lack of cover in the lake, attributed to large water level fluctuations, steep slopes, and poor soils, standing crops of centrarchid species are reduced. DWR has recently completed a six-year Habitat Improvement Plan that targets the warmwater fishery and juvenile black bass in particular. Catfish are also a popular fish to catch in the spring and summer. Primary forage fish in the lake are wakasagi and threadfin shad.

The Thermalito Diversion Pool is dominated by coldwater fish, including rainbow trout, brook trout, brown trout, and chinook salmon because of the cold water released from Lake Oroville. Salmon stocked in the Thermalito Forebay are free to move into the Diversion Pool since there is no barrier between the water bodies. Several trophy salmonids are caught in the Diversion Pool annually because of the relatively abundant supply of forage fish entering the pool from Lake Oroville.

The Thermalito Forebay is managed as a put-and-take trout fishery, where catchable rainbow and brook trout are stocked biweekly. The Forebay coldwater fishery is the second most popular reservoir fishery at Oroville. The diverse temperature structure of the Thermalito Afterbay has suitable habitat for both coldwater and warmwater fish. Salmonids present here likely have passed through the Thermalito Pumping-Generating Plant.

The Feather River Fish Hatchery is one of the best chinook salmon hatcheries on the west coast, making substantial contributions to both commercial and recreational fisheries. The hatchery mitigates for the loss of chinook salmon and steelhead trout from construction of the Oroville Facilities.

The lower Feather River is comprised of the eight-mile long low flow channel and 14 miles of the lower Feather River downstream of the Thermalito Afterbay outlet. Some areas of the low flow channel are armored due to the absence of gravel recruitment, but there are nine major riffles with suitable spawning size gravel. Flow in the low flow channel is regulated at 600 cfs, except during flood flow releases from Oroville Dam. Flow below the Afterbay Outlet typically is steady and ranges from 1,750 cfs in the fall to 17,000 cfs in the spring.

The lower Feather River supports a variety of anadromous and resident fish species, with chinook salmon and steelhead the most important from a sport fishing perspective. Angler harvest rates for chinook salmon were 18,000 and 26,000 in 1998 and 1999, respectively, but annual estimates from ocean catch of fall-run chinook from the Feather River ranged between 40,000 and 90,000 between 1975 and 1984, making it an important fishery. Other important species in the lower Feather River include striped bass and American shad. The Thermalito Afterbay Outlet is the most popular fishing spot in Butte County, hosting tens of thousands of anglers annually.

The Oroville Wildlife Area contains over 75 warmwater ponds and sloughs that support abundant populations of largemouth bass, channel catfish, white catfish, bluegill, green sunfish, and carp.

Botanical Resources

Within the project boundary there are about 20,000 acres of native vegetation, developed areas, and other disturbed areas. Significant areas of native vegetation occur within the areas surrounding Lake Oroville and in the lower elevations associated with the Forebay and Afterbay. The U.S. Forest Service and Bureau of Land Management manage about 4,000 acres of the terrestrial lands.

In general, vegetation types within the project boundary are dominated by chaparral shrubs/woodland types or grassland/riparian types. In the vicinity of Lake Oroville and the Thermalito Diversion Pool, the dominant vegetation types are tree series (oak series and conifer series) and shrub series. These vegetation types are not considered rare, but they do provide habitat for a number of the sensitive plant species of the region.

Some of the lower elevations of the project area are dominated by the California annual grassland series, with some of these areas having spectacular wildflower displays in the spring. Ephemeral wetlands of the sedge and spikerush series and northern hardpan vernal pools are present throughout these lower elevation grasslands. While common in the project area, vernal pool habitat is considered rare in the sense that much of the habitat has been eliminated on a state-wide basis. The vernal pools provide habitat for a number of federally listed invertebrate and plant species, including the endangered fairy shrimp.

There are no records of federally listed endangered or threatened plant species within the Oroville Facilities project area. However, four federally listed plant species do occur near the project. Twenty plant species are listed as federal Species of Concern within or adjacent to the project boundary.

A number of plant species considered noxious weeds occur near or within the project area. Four of these species are high priority target species: purple loosestrife, giant reed, yellow starthistle, and parrot's feather. There are a number of ongoing control/eradication projects for these species.

Several culturally important plant species also occur within the project area. Important plant foods include pines, oaks, buckeye, cattail, hazelnut, and berries.

Riparian vegetation along the lower Feather River is fairly restricted or absent in many areas. The most extensive zones are found within the Oroville Wildlife Area and south of Marysville.

Wildlife Resources

The diversity of wildlife habitats within and adjacent to the project area support a variety of wildlife species, including numerous recreational/commercial species and special status species. Five land management agencies manage the wildlife habitat within the project area. Wildlife habitat types within the project area are dominated by lacustrine (ponds and lakes), blue oak/foothill pine, and valley foothill riparian.

A variety of commercially or recreationally important wildlife species occur, including black-tailed deer, waterfowl, and upland game species (e.g., mourning dove, wild turkey, pheasant, and quail). The deer population declined in the 1960s through the early 1980s, with rural residential growth considered the major limiting factor. Waterfowl are the most important commercial and recreational group of wildlife in the lower elevation portions of Butte County. Portions of the Oroville Wildlife Area within the project boundary are managed by the DFG to provide habitat for nesting and wintering waterfowl.

Fifteen state or federally listed species (including candidate species) may occur within the project area. Seven of these (Aleutian Canada goose, bank swallow, Swainson's hawk, western yellow-billed cuckoo, California red-legged frog, giant garter snake, and vernal pool fairy shrimp) have been documented in the project vicinity. Limited amounts of habitat exist for each of these seven species.

Cultural Resources

Human occupation of the northern Sacramento valley may span 10,000 years or more. Much of the recorded prehistory of the area is due to the intensive archeological investigations that were conducted along the Feather River in association with construction of Oroville Dam. The cultural sequence of the area is divided into four phases that span 1000 BC to 1850 AD: Mesila, Bidwell, Sweetwater, and Oroville.

The project area is located in the ethnographic territory of the Konkow Indians, also known as the Northwestern Maidu. Within the Lake Oroville area, all the prehistoric archaeological periods are represented. Several archaeological studies have been conducted in the project area. Hines (1987) conducted an analysis of archaeological sites and concluded that there were 196 sites in the project area, with 127 sites seasonally exposed during low pool elevations or completely above the inundation zone (i.e., 78 sites in the fluctuation zone between elevation 640 and 900 feet and 49 sites above the high pool elevation). Including surveys conducted since then, a revised total of 173 sites are now completely or periodically accessible.

The settlement of Oroville by Europeans began when gold was discovered at the site in 1849. By 1856 Oroville was the fifth largest town in California. When the surface gold diggings were largely exhausted, Oroville went into a period of economic and demographic decline. Grain growing in the 1860s and citrus and olive production in the late 19th century became especially important. In the 1890s, mining again became important with the development of river dredging. By 1930, dredging companies had moved out of the area. The huge tailings of rock and boulders from the dredging operations were used in the construction of Oroville Dam; however, dredge spoils are still evident in the project area near the Thermalito Facilities and the Oroville Wildlife Management Area.

Several historic properties associated with Lake Oroville have qualified for local, state, and federal recognition. Notable historical objects include the Bidwell Bar Bridge, Old Toll House, and Mother Orange Tree. However, no historic properties at Lake Oroville have been determined eligible or are listed on the National Register of Historic Places (NRHP).

In the lower Feather River area, archaeological sites indicate intensive occupation over a long time period; deep, stratified, multi-component midden deposits denote village settlements, with associated cemeteries, structural depressions, and milling stations. The Table Mountain Boulevard Bridge is the only resource within the lower Feather River project area listed in the NRHP. Additionally, 20 sites that have been recorded are still thought to exist in the lower Feather River project area.

Recreational Resources

There are a number of recreational opportunities within a one to two hour drive of Oroville and within the project vicinity including Plumas National Forest, Highway 70 Scenic Byway, Feather Falls Scenic Area, and the North Fork Feather River Hydroelectric Projects. Existing facilities at the Oroville Complex host a variety of recreational opportunities including boating, fishing, camping, picnicking, swimming, horseback riding, hiking, bicycling, wildlife viewing, and hunting. The major recreation facilities include the Lake Oroville Visitor Center, Loafer Creek Recreation Area, Lime Saddle Recreation Area, Lime Saddle and Bidwell Canyon Marinas, Freeman Bicycle Trail, Lake Oroville Horse Trail, Oroville Wildlife Area, and the North Thermalito Forebay Recreation Area. Recreation opportunities are also available at the South Thermalito Forebay, Thermalito Afterbay, the Diversion Pool, and the low flow channel of the Feather River.

Lake Oroville provides many year-round recreation opportunities, but these opportunities can be affected by lake levels. As the water levels decrease during the recreation season, the use of certain recreational facilities such as boat launch ramps, car-top boat launches, and boat-in camps is increasingly affected. Low water also impairs boat access to some recreation sites such as the spectacular Feather Falls.

Recreation use at the Lake Oroville State Recreation Area (LOSRA) was estimated at one million visitors in 1997, with boating the primary activity of most visitors. Boat fishing, water skiing, and pleasure boating are the three activities visitors stated most often as their primary activity. Based on a survey, visitors enjoyed their experience.

Socioeconomics

Socioeconomic activity generated by recreational use of the Oroville Facilities is concentrated within Butte County. Recreation and tourism-related travel expenditures in the county generated an estimated 3,300 jobs in 1998, and an estimated $47.1 million in payroll expenditures, representing 1.2 percent of income within Butte County. With a per capita income of about $20,840 the county is ranked 37th among California's 52 counties. Based on the one million visitors in 1997, recreation visitation generated about $5.7 million in local expenditures, with much of the spending generated by persons within Butte County.

At the local level, unemployment in the Oroville area was generally higher than the countywide rate in 1999, with an estimated unemployment rate of 9.7 percent in the City of Oroville. Based on the higher unemployment rates, per capita incomes in the Oroville and Thermalito areas are likely lower than the countywide per capita income. Approximately 52 percent of the $5.7 million in expenditures from the LOSRA visitation is associated with visits at the southern end of LOSRA near Oroville.

Land Use and Management

The vast majority of land use in the region surrounding the project boundary is used for agriculture, timber, and grazing. Similar to the larger region, most of the lands surrounding Lake Oroville consist of undeveloped forest, brush, and grazing lands. The only area in proximity to the lake's edge with urban or suburban development is on Kelly Ridge, which is east of the dam. At the north end of the lake, several small areas along the North and Middle Forks of the Feather River lie within the Plumas National Forest and are subject to the provisions of the Plumas Forest Plan.

Both the Forest Service and the U.S. Bureau of Land Management (BLM) manage federal lands within the project boundary. BLM properties total about 6,300 acres. Most of the land within the project boundary is managed at the state level, with the state Department of Parks and Recreation (DPR) managing recreation use of project area lands, primarily under fee title ownership of the DWR. The DFG manages the Oroville

Wildlife Area. No privately owned lands exist in the project area, but there are privately run marinas and campgrounds along the shoreline. These facilities are under contract with the state.

The project area is primarily managed through seven land and resource management plans. In general, these plans emphasize resource conservation, provision of high quality recreational opportunities, and protection of visual resources. The LOSRA Resource Management and General Development Plan describes allowable recreational uses and intensities for various areas around the lake. The DPR manages shoreline areas in accordance with this plan.

Aesthetics

The development of the Oroville Facilities represented a significant engineering and construction achievement. Because of the scale of the project, the dams, reservoirs, and related facilities are now among the most visually important elements of the area's landscape. Although the scenery in the foothill region around the facilities is attractive, it is generally of local and regional importance, not state or national importance. A notable exception is the Middle Fork arm upstream of the lake, which is designated a Wild and Scenic River. In addition, this area is the site of several waterfalls, including Feather Falls on the Falls River.

Lake Oroville is visible from many locations. It is most attractive when it is at its maximum operating level. As drawdown occurs during the summer and fall, an increasingly broad ring of shoreline appears in the area between the normal high water mark and the actual lake level. The drawdown zone contrasts with the vegetated areas above the high water level and with the lake's surface. As a consequence of reservoir operations, the lake's appearance tends to be very good in late spring and early summer, but declines in July and August with increasing drawdown.

RESOURCE ISSUES AND CURRENT AND PROPOSED STUDIES

DWR is currently conducting studies based on existing requirements that may apply to relicensing needs. DWR anticipates that these studies may be modified and adapted for relicensing requirements based on discussions at the Work Group level. DWR also has preliminarily identified relicensing issues, and has recently initiated discussions at the Work Group and Plenary Group levels to develop the issues and study plans. Therefore, the issues and studies described below must be considered preliminary in nature. The studies focus on the evaluation of the effects of the project on environmental resources.

Water Quality
Water temperatures are an issue of concern for both aquatic resources and agricultural interests. Temperature monitoring is ongoing, and plans are to examine how specific water releases and operations will affect temperatures in the river, Afterbay, and hatchery.

Aquatic Resources
Several fish hatchery issues need resolution, such as the relationship between the hatchery and restoration of a natural ecosystem, straying and genetic impacts, harvest rates, and disease.

Ongoing studies in the lower Feather River include adult and juvenile steelhead snorkel surveys and a habitat inventory, beach seine surveys to determine the temporal and spatial rearing extent of juvenile steelhead and salmon, rotary screw trap sampling of chinook salmon to monitor the timing and number of emigrants, chinook egg survival studies, particularly in the low flow channel, chinook spawning escapement surveys, redd de-watering and juvenile surveys in the Lower Reach, effects of water temperatures on juvenile steelhead rearing, steelhead creel surveys to gather adult steelhead life history data, and invertebrate research.

Terrestrial Resources
DWR anticipates conducting studies on sensitive species occurrence and distribution within the project area, developing a vegetation/habitat map, and collecting information on recreational wildlife use within the Oroville Wildlife Area and State Park lands.

Cultural Resources
DWR plans to inventory archaeological, historical, and traditional cultural resources, and evaluate their eligibility for listing in the National Register of Historic Places. Further, the project effects on any historic properties would be documented and measures to avoid impacts implemented. The Cultural Resources work would include a Stage I Survey and possibly a Stage II survey as well. The objective of the studies would be to develop a Cultural Resources Management Plan.

Recreational Resources
The major recreation issue is what types and level of recreation facilities would be needed to accommodate additional recreation demand at the LOSRA. Recreational resource studies would be needed to address this issue. The studies may include: recreation supply analysis, recreation surveys, demand analysis, capacity and suitability analysis, needs analysis, and a Recreation Resources Management Plan. These studies would be used in developing an overall recreation plan for the LOSRA.

Socioeconomic Resources
One of the key socioeconomic issues is to develop an understanding of how the recreation activity affects the local and regional economy. Another issue is the potential economic benefits from using Lake Oroville water for municipal, agricultural, and industrial purposes. DWR is proposing several baseline studies to address these socioeconomic issues.

Land Management
Primary land management issues are related to the effects of newly developed recreational facilities on adjacent land uses. Other issues are compatibility of new residential development on existing land use and land ownership.

To address the management issues, several baseline studies would be performed including a land use inventory, evaluation of the consistency of existing land uses with regulations and management plans, and identification of the area's natural and sensitive resources.

Aesthetic Resources
An important aesthetic issue is the effect of the exposed shoreline that accompanies reservoir drawdowns. To assess this issue, it may be appropriate to undertake a study to understand the aesthetic consequences of variations in water level fluctuations. The visually important segments of the low flow channel may also warrant study.

This page was left blank intentionally.

CONTENTS

APPENDICES

FIGURES

This page was left blank intentionally.

TABLES

ACRONYMS AND ABBREVIATIONS

4WD	4-wheel drive
ac	acre
af	acre-feet
ALP	Alternative Licensing Procedures
APEA	Applicant Prepared Environmental Assessment
BCDA	Butte County Department of Agriculture
BLM	U.S. Bureau of Land Management
CALFED	State (CAL) and federal (FED) agencies participating in Bay-Delta Accord
CALISO	California Independent System Operation
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGAP	California GAP Analysis Project
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CSU	California State University
CTR	California Toxics Rule
CWA	Clean Water Act
CWHR	California Wildlife Habitat Relationship Program
DFG	California Department of Fish and Game
DHS	California Department of Health Services
DO	dissolved oxygen
DO&M	Division of Operations and Maintenance
DPR	California Department of Parks and Recreation or Department of Pesticide Regulation
DWR	California Department of Water Resources
EA	environmental assessment

ECPA	Electric Consumers Protection Act
EIR	environmental impact report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESU	Evolutionarily Significant Unit
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
fps	feet per second
FR-CRM	Feather River Coordinated Resource Management
GIS	geographic information system
ft	foot or feet
HAER	Historic American Engineering Record
hp	horsepower
IIP	Initial Information Package
in	inch
IMPLAN	
LFC	low flow channel
LFR	Lower Feather River
LNF	Lassen National Forest
LNP	Lassen National Park
LOSRA	Lake Oroville State Recreation Area
LR	lower reach
LRMP	Land and Resource Management Plan
m	meter
maf	million acre-feet
MCL	Maximum Contaminant Level
MF	Middle Fork
mgd	million gallons per day
mg/L	milligrams per liter

MTBE	methyl-tertiary butyl ether
msl	mean sea level
MW	megawatt
MWhrs	megawatt hours
NEPA	National Environmental Policy Act
NF	North Fork
NGO	non-governmental organization
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NRHP	National Register of Historic Places
NTR	National Toxics Rule
NTU	nephelometric turbidity unit
O&M	operations and maintenance
OCO	Operations Control Office
OFD	Oroville Field Division
OHV	off-highway vehicle
ORV	off-road vehicle
OWA	Oroville Wildlife Area
PCBs	polychlorinated biphenyls
PCT	Pacific Crest Trail
PG&E	Pacific Gas and Electric Company
PNF	Plumas National Forest
QLG	Quincy Library Group
R&PP	Recreation and Public Purposes Act
RD	reclamation district
RM	river mile
RRMP	Recreation Resources Management Plan
RV	recreational vehicle

RWQCB	Regional Water Quality Control Board
SCS	U.S. Soil Conservation Service
SCE	Southern California Edison Company
SF	South Fork
SHPO	State Historic Preservation Officer
SMP	Shoreline Management Plan
SMS	Scenic Management System
SWP	State Water Project
SWRCB	State Water Resources Control Board
taf	thousand acre-feet
TCPs	traditional cultural properties
TDS	total dissolved solids
UC	University of California
UNFFR	Upper North Fork Feather River
USBR	U.S. Bureau of Reclamation
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1.0 INTRODUCTION

1.1 CONTENT AND PURPOSE OF THIS DOCUMENT

The California Department of Water Resources (DWR) is a department of the State of California whose stated mission is “To manage the water resources of California, in cooperation with other agencies, to benefit the state’s people and protect, restore, and enhance the natural and human environments.” The department planned, designed, oversaw the development of, and now operates and maintains the State Water Project (SWP), the largest state-built multipurpose water project in the United States. The SWP collects and stores water from Northern California watersheds and delivers it to agricultural areas in the San Joaquin Valley and urban regions in the San Francisco Bay Area, Central Coast, and Southern California. Although the SWP was built primarily for water supply, it is a multipurpose project whose benefits also include flood control, power generation, recreation, fish and wildlife enhancement, and salinity control in the Sacramento-San Joaquin Delta. The Oroville Facilities are a critical part of the SWP, providing much of the system’s water collection and storage, flood control, and power production capacity.

The DWR owns and operates the Oroville Facilities under a license that was issued in 1957 by the Federal Power Commission, the predecessor of the Federal Energy Regulatory Commission (FERC, or the Commission). The project license (FERC Project No. 2100) expires on January 31, 2007. In anticipation of this, the DWR intends to submit an application for a new FERC license at least two years prior to the expiration date.

This Initial Information Package (IIP) introduces the relicensing program for the Oroville Facilities project. The relicensing process proposed is based on cooperation and collaboration with federal and state resource agencies, Indian Tribes, local governments, non-governmental organizations (NGOs), and interested members of the public. This process is referred to as the Alternative Relicensing Procedures (ALP), as described in more detail in Section 1.7 of this IIP. The DWR has requested that the Commission approve the ALP for the Oroville Facilities relicensing. FERC approved the ALP process on January 11, 2001.

As a part of the relicensing process, the DWR has prepared this IIP to acquaint resource agencies and the public with the project and the environmental resources potentially affected by current and future project operations. The IIP provides basic but comprehensive information about the project's facilities and what is known about the project's influence on the surrounding environment and resources. In addition, it identifies resource areas where additional information may be needed to make informed and responsible decisions about future project operations.

1.2 GENERAL LOCATION

The Oroville Facilities are located on the Feather River at the foothills of the Sierra Nevada in Butte County in Northern California. The facilities and the project boundary extend from the area south and west of the City of Oroville, and east into the reaches of the Feather River's South, Middle, and North Forks (see Figure 1-1, found in the inside pocket of the report's back cover).

1.3 PROJECT PURPOSES

The Oroville Reservoir (also known as Lake Oroville), one of the key elements of the Oroville Facilities, is the principal water storage facility for the SWP, which stores and delivers water to over two-thirds of California's population. Lake Oroville, with a gross capacity of 3,540,000 acre-feet, is operated for water supply, power generation, flood control, recreation, and fishery and wildlife habitat enhancement. The water conserved in the reservoir is used beneficially throughout the state for a variety of purposes, including irrigation, municipal and industrial use, and environmental needs.

1.4 OROVILLE FACILITIES

The principal facilities include Oroville Dam and Reservoir, the Edward Hyatt Hydroelectric Powerplant, Thermalito Powerplant, Thermalito Diversion Dam Powerplant, Thermalito Forebay and Afterbay, and associated recreational and fish and wildlife preservation and enhancement facilities. The locations of these features and their relationships to each other as well as the project boundary are indicated on Figure 1-1. The hydroelectric facilities at the Oroville Facilities have a combined licensed capacity of approximately 762 megawatts (MW).

1.5 THE EXISTING FEDERAL LICENSE

On February 11, 1957, the Federal Power Commission, predecessor to the FERC, issued a 50-year license, effective February 1, 1957, to DWR to construct and operate the Oroville Facilities (FERC Project No. 2100) in Butte County, California. The existing

FERC license for Project No. 2100 expires on January 31, 2007. DWR must file a Notice of Intent (NOI) to seek a new license by January 31, 2002 and its application for a new license by January 31, 2005.

1.6 CURRENT FERC LICENSING REGULATIONS

The Federal Energy Regulatory Commission, under the Federal Power Act (FPA), has the authority and responsibility for regulating non-federally owned hydroelectric power projects on navigable waterways and federal lands. The October 1986 Electric Consumers Protection Act (ECPA) amended the Federal Power Act. Major changes to the act include the following:

- Established new procedures for processing relicense applications to increase opportunities for agencies, interested organizations, and the public to participate in the process.

- Requires the Commission to base its recommendations for mitigating adverse effects of a licensing proposal on the recommendations of federal and state fish and wildlife agencies and to negotiate with the agencies if disagreements occur.

- Requires the Commission to give equal consideration to the environment, recreation, fish and wildlife, and other non-power values that it gives to power and development objectives in making a licensing decision.

The FERC conducts an independent analysis of relicense applications to determine if a new license should be issued and what terms and conditions will be included as part of a new license. The FPA requires the FERC to give equal consideration to a full range of purposes related to the potential values of a stream or river. These purposes include hydroelectric development, energy conservation, fish and wildlife resources, recreational opportunities, other aspects of environmental quality, irrigation, flood control, and water supply. The FERC is required to consider whether a project is adapted as well as possible to a comprehensive plan for developing the waterway. To satisfy this requirement, the FERC considers comprehensive plans prepared by federal and state entities and the recommendations of federal and state resource agencies, Indian Tribes, and the public affected by the project. The impact analysis and mitigation must focus on the ongoing impacts of the project as it currently exists.

The Traditional Relicensing Process incorporates specific steps to prepare and file a new license application. Under this process, prior to filing, a licensee consults with the appropriate federal and state resources agencies to identify needed studies and incorporate information from completed studies into a new license application for an existing hydroelectric project. The license application, prepared and submitted by the licensee to the FERC, presents information about the project, the resources in the project area, and the licensee's protection, mitigation, and enhancement proposals, along with those measures proposed by other parties but not adopted by the licensee. After submittal of the license application, the FERC performs an independent environmental and engineering review of the project. During this step, resource agencies, Indian Tribes, the public, and the licensee can provide comments. A collaborative process is typically not used throughout the process to discuss the potential license terms and conditions submitted to the FERC. Until the Energy Policy Act of 1992, the Traditional Relicensing Process was the only process available to a licensee.

1.7 ALTERNATIVE LICENSING PROCEDURES

A licensee may select either the Traditional Relicensing Process or the Alternative Licensing Procedures (ALP) to prepare, file, and process a new license application for an existing hydroelectric project. The licensee must obtain FERC approval to utilize the alternative licensing process. These two relicensing processes differ primarily to the extent and timing of collaboration with relicensing participants during relicensing activities, as well the timing and sequence of the FERC's and other regulatory agencies' environmental review process.

The ALP enables the licensee and participants to collaboratively design the consultation process for the relicensing task. The ALP allows the licensee and participants to jointly propose license terms and conditions, which can be submitted to the FERC with the license application. Through the collaborative process, the ALP encourages greater public involvement and provides the opportunity for participants to tailor the process to address specific issues and streamline procedural compliance with multiple federal laws.

Also, the ALP combines the traditional process pre-filing consultation with some of the National Environmental Policy Act (NEPA) requirements fulfilled by the FERC. The FERC regulations allow for an integration of pre-filing consultations with the environmental analysis, permitting the licensee to prepare or have prepared an Applicant Prepared Environmental Assessment (APEA) or an Environmental Impact Statement

(EIS) to meet the requirements of NEPA. The draft APEA or EIS is filed with the FERC along with the license application.

The ALP may include the development of settlement agreements between relicensing participants. A settlement agreement may detail a preferred project mitigation strategy that has been agreed upon the relicensing participants. Ideally, any settlement agreement would be included in the APEA and would be used by the FERC as a basis for the new license terms and conditions.

DWR plans to use the ALP to prepare its license application. DWR will engage a collaborative process to consult with federal and state resource agencies, Indian Tribes, local organizations, non-governmental organizations, and other interested parties. DWR believes that the ALP offers the best opportunity to obtain input and feedback from a broad array of interests in an atmosphere of cooperation and trust. The ALP alternative under consideration by DWR is the APEA process.

1.8 GOALS FOR OROVILLE FACILITY RELICENSING

The primary goal of the ALP is to reach a negotiated settlement agreement with the stakeholders that will form a basis for the relicense application.

1.9 THE RELICENSING TIMELINE

The proposed schedule for relicensing the Oroville Facilities is presented in Figure 1-2.

1.10 HOW TO GET INVOLVED

The FERC relicensing process for the Oroville Facilities is open to the public, and broad participation is encouraged. A three-tiered collaborative process will be used to achieve consensus on relicensing the Oroville Facilities. The three tiers, described below, are the Plenary Group, Working Groups, and Task Forces. Interested individuals can actively participate in the process at whatever level they choose.

Click here to access Figure 1-2

If one chooses not to participate directly in the collaborative process, there are other means of becoming involved and staying informed. The Oroville Facilities Relicensing website (http://orovillerelicensing.water.ca.gov/) contains project information, meeting notices and minutes, newsletters, and other related information. Also available for those that want to submit comments are a toll free telephone number 1-866-820-8198 and an email address orovillep2100@water.ca.gov. A newsletter containing information about Oroville Facilities relicensing activities will be distributed quarterly.

The Plenary Group will serve as the forum in which to ultimately decide the terms of the settlement agreement. The Plenary Group will receive updates regarding the efforts of the various Work Groups, seek to understand what is being done in the studies, and provide suggestions. With input from the Work Groups, the Plenary Group will work to develop the final terms of the agreement. In considering the recommendations of the Work Groups, the Plenary Group will give deference to the Work Groups to the extent possible, seeking to integrate these recommendations into a consistent, complete, and implementable package.

The Work Groups will serve as the forum in which to reach agreement on study objectives, based on the questions that participants want the studies to help answer. Work Groups will lead the design of studies, monitor the progress of the studies, analyze and interpret study results, and develop recommendations to the Plenary Group. The Work Groups will develop the study plans unless consensus for a particular study does not exist. If consensus on a study plan is not reached, the Work Group can elevate the issue to the Plenary Group for resolution. The Plenary Group will consider the issues, including the statutory responsibility of the resource agencies, which could choose not to accept the decision of the Plenary Group if it conflicts with their statutory responsibilities.

A Task Force may be composed of members of one or more Work Groups. Task Forces are formed by the Work Groups to examine specific issues in greater detail and to report their findings back to the Working Groups.

Expectations of participants in these groups are listed as follows:

- Attend scheduled meetings or send alternate,
- Make informed choices when prioritizing management and research activities,

- Strive to understand issues within the study area that may not directly relate to personal or geographic areas of interest,
- Actively participate and carry ideas of the group you represent to the process, and
- Relay ideas and proposals discussed at meetings back to the group you represent.

2.0 DESCRIPTION OF THE PROJECT

2.1 OVERVIEW OF THE OROVILLE FACILITIES

The Oroville Facilities include Lake Oroville (the state's second largest reservoir), Oroville Dam, three powerplants (Edward Hyatt Powerplant, Thermalito Diversion Dam Powerplant, Thermalito Pumping-Generating Plant), Thermalito Diversion Dam, the Fish Barrier Dam, the Feather River Fish Hatchery, Thermalito Power Canal, Thermalito Forebay, and the Thermalito Afterbay. The locations of these project features are indicated on Figure 2-1. (Figure 1-1, found in the inside pocket of the report's back cover, provides more detail on the locations of the project facilities and indicates the boundaries of the project area as well.)

The Oroville Facilities are a part of the State Water Project, one of the largest water and power systems in the world. The SWP includes 17 pumping plants, 32 storage facilities (mainly reservoirs and lakes), five hydroelectric powerplants, three pumping-generating plants, and more than 660 miles of canals, tunnels, and pipelines (Figure 2-2). The Oroville Facilities, which are located at the upstream end of the SWP, have the capacity to store over 3.5 million-acre feet of water and account for most of the SWP's water capture and storage. Water released from the Oroville Facilities into the Feather River flows south, joins the Sacramento River, and flows into the Sacramento-San Joaquin Delta. At the north end of the Delta, some of this water is pumped into the North Bay Aqueduct and routed west to provide a supplemental water supply to Solano and Napa counties. The rest of the water from the project flows south through the Delta to the Clifton Court Forebay, a large, shallow reservoir at the Delta's southern edge, where the project's water is collected and stored. From the forebay, the water enters the Banks Pumping Plant, which lifts the water 244 feet up to the Bethany Reservoir. From the Bethany Reservoir, some of the water is routed into the South Bay Aqueduct, which delivers water to Alameda and Santa Clara counties, and the rest is routed into the California Aqueduct, which conveys the water to agricultural and urban users in the San Joaquin Valley, Central Coast, and Southern California. Operation of the SWP requires over 13.7 billion kilowatt-hours of electricity a year to pump deliveries of 4.2 million acre-feet of water. The project's electric power needs are met, in part, by the output of the three powerplants that are a part of the Oroville Facilities.

Click here to access Figure 2-1

Click here to access Figure 2-2

2.2 ENGINEERING DESCRIPTION OF THE PROJECT

2.2.1 Oroville Facilities

2.2.1.1 Oroville Dam

Oroville Dam is depicted in Figure 2-3, and Figure 2-4 includes a plan of the dam and surrounding area and a cross-section of the dam structure. Construction of the dam began in 1961 and was completed in 1968. It is a zoned earthfill dam and has an embankment volume of 80,000,000 cubic yards. At 770 feet high, it is the highest earthfill dam in the United States. The crest of the dam is 6,920 feet long, 51 feet wide, and at an elevation of 922 feet.

The spillway, located on the right abutment of the dam, has two separate elements: a controlled gated outlet and an emergency uncontrolled spillway. The gated control structure was designed to permit controlled releases of up to 150,000 cubic feet per second (cfs) into a concrete-lined chute that extends to the river. The emergency uncontrolled spillway is designed so that if the reservoir were to fill above 901 feet, water could flow over the emergency spillway weir and down the undeveloped canyon slope to the river.

2.2.1.2 Lake Oroville

Lake Oroville (Figure 1-1) stores winter and spring runoff that is released into the Feather River, as necessary, for project purposes. Two small embankments, Bidwell Canyon and Parish Camp Saddle dams, complement Oroville Dam in containing Lake Oroville. The reservoir has a storage capacity of 3,538,000 acre-feet and is fed by the North, Middle, and South Forks of the Feather River. Average annual unimpaired runoff into the lake is about 4.2 million acre-feet (maf). The water surface elevation and water surface area at maximum operating storage are 900 feet and 15,810 acres, respectively. The shoreline covers 167 miles at maximum operating storage.

Click here to access Figure 2-3

Lake Oroville, Dam, and Diversion Pool

Click here to access Figure 2-4

2.2.1.3 Edward Hyatt Powerplant

Located in rock in the left abutment near the axis of Oroville Dam, Edward Hyatt Powerplant is an underground, hydroelectric pumping-generating facility (Figure 2-5). Construction of the plant began in 1964 and was completed in 1967.

A maximum flow of 17,000 cfs can be released through Edward Hyatt Powerplant. Three of the six units are conventional generators driven by vertical-shaft, Francis-type turbines; the other three are generator/motors coupled to Francis-type, reversible pump turbines. The latter units allow pumped storage operations[2]. The intake structure has an overflow type shutter system that determines the level from which water is drawn.

Table 2-1 summarizes the pumping and generating information for the Edward Hyatt Powerplant.

Table 2-1: Pumping And Generating Information For Edward Hyatt Powerplant

	Pumping	**Generating**
Installed Capacity	5,610 cfs & 519,000 hp	645 MW & 16,950 cfs
Normal Static Head	500-660 feet	410-676 feet
Design Dynamic Head	592 feet	615 feet
Number of Units	3 pumping/generating	6 (3 generating, 3 pumping/generating)
Unit Size	1,870 cfs & 173,000 hp	3 @ 115 mVA & 2,800 cfs
		3 @ 123 mVA & 2,850 cfs
Penstock Diameter		2 @ 22 feet

[2] Edward Hyatt Powerplant maximizes the value of power production through a pumped-storage operation where water, released for power in excess of local and downstream requirements, is pumped back into Lake Oroville during off-peak periods and is used for power generation during peak power demands.

Click here to access Figure 2-5

2.2.2 Thermalito Diversion Facilities

2.2.2.1 Thermalito Diversion Dam

Approximately four miles downstream of Oroville Dam and Edward Hyatt Powerplant is the Thermalito Diversion Dam (Figures 2-6, 2-7, and 2-8). This facility, which was constructed between 1963 and 1968, consists of a 625-foot-long, concrete gravity dam with a regulated ogee spillway that releases water to the Low Flow Channel of the Feather River. The dam has an embankment volume of 154,000 cubic yards, a height of 143 feet, a crest length of 1,300 feet and an elevation of 233 feet.

The dam has two purposes: (1) it diverts water into the two-mile-long Thermalito Power Canal, which transports it to the Thermalito Pumping-Generating Plant for power generation (Figure 2-6); and (2) it creates a tailwater pool (called Thermalito Diversion Pool) for the Edward Hyatt Powerplant.

2.2.2.2 Thermalito Diversion Pool

The Thermalito Diversion Pool (Figures 2-3, 2-6, and 2-9) acts as a forebay when the Edward Hyatt Powerplant is pumping water back into Lake Oroville. The Diversion Pool holds a maximum of 13,350 acre-feet. The water surface elevation and water surface area at maximum operating storage are 225 feet and 320 acres, respectively. The shoreline covers 10 miles at maximum operating storage.

Click here to access Figure 2-6

Click here to access Figure 2-7

Click here to access Figure 2-8

Click here to access Figure 2-9

2.2.2.3 Thermalito Diversion Dam Powerplant

The Thermalito Diversion Dam Powerplant (Figure 2-10) is on the left abutment of the Thermalito Diversion Dam. It was constructed between 1985 and 1987. The powerplant generates electricity from water released to the Low Flow Section of the Feather River to maintain fish habitat between the Diversion Dam and the Thermalito Afterbay River outlet. It releases a maximum of 615 cfs to the Low Flow Channel of the river. Table 2-2 lists the generating information for the Thermalito Diversion Dam Powerplant.

Table 2-2: Generating Information for Thermalito Diversion Dam Powerplant

Installed Capacity	3 MW & 615 cfs
Normal Static Head	63-77 feet
Design Dynamic Head	67 feet
Number of Units	1
Unit Size	3.3 MVA & 615 cfs
Discharge Lines/Diameter	2 @ 5 feet to 1 @ 7.5 feet

2.2.2.4 Thermalito Power Canal

Thermalito Power Canal (Figures 2-6 and 2-7) hydraulically links the Thermalito Diversion Pool to the Thermalito Forebay and can convey water in either direction between the two facilities. The water in the Power Canal is used for pumping and power generation at the Edward Hyatt Powerplant and Thermalito Pumping-Generating Plant.

The headwork structure for the Thermalito Power Canal is located on the right abutment of the Thermalito Diversion Dam. The Power Canal is a concrete-lined canal 10,000 feet in length. The maximum generating and pumping flows are 16,900 cfs and 9,000 cfs, respectively.

Click here to access Figure 2-10

2.2.3 Thermalito Forebay Facilities

2.2.3.1 Thermalito Forebay Dam

The Thermalito Forebay Dam (Figures 2-11 and 2-12) was constructed between 1965 and 1968. It is located about four miles west of the City of Oroville. The dam is a homogeneous and zoned earthfill dam. It has an embankment volume of 1,840,000 cubic yards, a height of 91 feet, and a crest length and elevation of 15,900 feet and 231 feet, respectively.

2.2.3.2 Thermalito Forebay

Thermalito Forebay (Figures 2-6, 2-11, and 2-12) is the off-stream regulating reservoir for the Thermalito Pumping-Generating Plant. It is contained by the Thermalito Forebay Dam on the south and east and by Campbell Hills on the north and west. The Forebay has three purposes: (1) it conveys generating and pumping flows between the Thermalito Power Canal and Thermalito Pumping-Generating Plant; (2) it provides regulatory storage and surge damping for the Hyatt-Thermalito power complex; and (3) it serves as a recreational site.

Thermalito Forebay holds a maximum of 11,768 acre-feet of water. The water surface elevation and water surface area at maximum operating storage are 225 feet and 630 acres, respectively. The shoreline covers 10 miles at maximum operating storage.

Click here to access Figure 2-11

Click here to access Figure 2-12

2.2.3.3 Thermalito Pumping-Generating Plant

The Thermalito Pumping-Generating Plant (Figures 2-11 and 2-13) was constructed from 1964-1969 with operations beginning in 1968. It is operated in tandem with the Edward Hyatt Powerplant to produce power during times of peak electric demand. Table 2-3 provides the pumping and generating information for the plant.

Table 2-3: Pumping and Generating Information for Thermalito Pumping-Generating Plant

	Pumping	Generating
Installed Capacity	9,120 cfs & 120,000 hp	114 MW & 17,400 cfs
Normal Static Head	85-102 feet	85-102 feet
Design Dynamic Head	99 feet	95 feet
Number of Units	3 (pumping/generating)	4 (1 generating, 3 pumping/generating)
Unit Size	3,040 cfs & 40,000 hp	3 @ 28 mVA (p/g) & 4,200 cfs 1 @ 36 mVA (g) & 4,800 cfs
Penstock/ Diameter		1 @ 24 to 21 feet 3 @ 21 to 18 feet

Click here to access Figure 2-13

2.2.4 Thermalito Afterbay

2.2.4.1 Thermalito Afterbay Dam

Thermalito Afterbay Dam (Figures 2-14, 2-15, and 2-16) is located about six miles southwest of the City of Oroville. The dam was constructed from 1965 – 1968. It is a homogeneous earthfill dam with the longest crest (42,000 feet) in the SWP system. It has an embankment volume of 5,020,000 cubic yards, a height of 39 feet and a crest elevation of 142 feet.

2.2.4.2 Thermalito Afterbay

The Thermalito Afterbay (Figures 2-14 and 2-15) has five purposes: (1) it provides storage for the water required by the pump-back operation to Lake Oroville; (2) it helps regulate the power system; (3) it produces controlled flow in the Feather River downstream from the Oroville Thermalito Facilities; (4) it provides recreational opportunities; and (5) it serves as a warming basin for agricultural water delivered to farms east of the afterbay.

The Thermalito Afterbay holds a maximum of 57,040 acre-feet of water. The water surface elevation and water surface area at maximum operating storage are 136.5 feet and 4,300 acres, respectively. The shoreline covers 26 miles at maximum operating storage.

Click here to access Figure 2-14

Click here to access Figure 2-15

Click here to access Figure 2-16

2.2.5 Fish Barrier Dam and Pool

2.2.5.1 Fish Barrier Dam

The Feather River Fish Barrier Dam (Figures 2-17 and 2-18) and Pool (Figure 2-17) are located upstream of the Feather River Fish Hatchery. They were constructed between 1962-1964. The dam diverts fish into a fish ladder that leads to the hatchery. The dam is a concrete gravity dam with a volume of 9,300 cubic yards. The height is 91 feet and the crest elevation and length are 181 feet and 600 feet, respectively.

2.2.5.2 Fish Barrier Pool

The Fish Barrier Pool has a storage capacity of 560 acre-feet and covers 50 acres. The shoreline covers one mile at gross capacity.

2.2.6 Feather River Fish Hatchery

The Feather River Fish Hatchery (Figure 2-19), completed in 1967, was built to compensate for spawning grounds lost to returning salmon and steelhead trout with the construction of Oroville Dam. The facility accommodates an average of 8,000 adult fish per year. Salmon and steelhead raised at the hatchery are transported in oxygenated, temperature-controlled tanks and released in the Feather and Sacramento rivers, in Lake Oroville and other California reservoirs, and in San Pablo Bay near San Francisco Bay. These fish account for an estimated 20 percent of the ocean sport and commercial catch of chinook salmon in the Pacific Ocean.

The facility is operated by the California Department of Fish and Game (DFG) and maintained by DWR.

2.2.6.1 Fish Ladder with Underwater Viewing Area

The fish barrier dam and pool, located upstream of the Feather River Fish Hatchery, divert fish into a fish ladder (Figure 2-20) that leads to the hatchery. The fish ladder is approximately ½ mile long and consists of a series of “steps” and pools. Pool length ranges from 8 to 1,000 feet, with a minimum width of six feet and a minimum water depth of two feet. Velocity of flow in the ladder ranges from two to five feet per second (fps), and the maximum drop between pools is one foot. Underwater passage of fish can be observed through 42-inch square viewing panels installed in the fish ladder wall.

Click here to access Figure 2-17

Click here to access Figure 2-18

Click here to access Figure 2-19

Click here to access Figure 2-20

An enlarged section of the fish ladder at its upstream terminus functions as a gathering tank, entrapping fish ascending the ladder. A mechanical sweep gathers the fish and deposits them into the abutting spawning building. Four concrete circular tanks hold the fish until they are ready to spawn.

2.2.6.2 Spawning-Hatchery Building

The spawning-hatchery building is where the artificial spawning takes place. Milt is taken from the male and mixed with eggs taken from the female. The eggs are kept in incubators capable of holding up to 25 million eggs.

The fry or young fish are held in incubators until they can be transferred to the rearing channels.

2.2.6.3 Rearing Channels

Young fish (fingerlings and yearlings) are held in rearing channels until they are ready for release. The rearing channels are concrete-lined raceways blocked off in intervals to form 48 individual pools 100 feet long and 10 feet wide. Water flow and velocity in the raceways are 3 to 5 cfs at 0.1 fps. The raceways are covered with netting to protect the fish from predators such as hawks and herons.

2.2.6.4 Thermalito Facility

Located on the west side of the Thermalito Afterbay, the Thermalito Facility is a set of fish rearing ponds (see Figure 2-14) used to raise salmon fry susceptible to the Sacramento River Chinook Disease (a coldwater virus) and young salmon. Its two rearing pond raceways can raise 2.5 million fingerlings for planting in San Pablo Bay or for study purposes.

2.3 TRANSMISSION LINES

There are no transmission lines associated with the Oroville Facilities.

2.4 PROPOSED CHANGES TO THE OROVILLE FACILITIES

At present, the DWR is not proposing any changes to the Oroville Facilities. However, changes to the design of the Oroville Facilities may occur as a result of the relicensing process.

3.0 PROJECT OPERATIONS

3.1 HOW THE POWERPLANTS WORK

Releases from Lake Oroville are routed through the Edward Hyatt Powerplant into the Feather River for power generation. Releases above Feather River instream requirements are then diverted from the Feather River into the Thermalito Forebay. The water not diverted from the Feather River at this point is discharged through Thermalito Diversion Dam Powerplant. The water in the Thermalito Forebay is routed through the Thermalito Pumping-Generating Plant into Thermalito Afterbay. Inflow to Thermalito Afterbay from peak power generation, in excess of local and downstream requirements, is stored for later release to the river. If energy price and availability factors are favorable the water stored in Thermalito Afterbay may be pumped back through Thermalito Pumping-Generation Plant and Edward Hyatt Powerplant into Lake Oroville during off-peak hours. A pump-back operation most commonly occurs when energy prices are high during weekday on-peak hours (when water is released for power generation) and low during the weekday off-peak hours or on the weekend (when water is pumped back into Lake Oroville for later power generation).

Local water supply diversions take water directly from the Thermalito Afterbay. The total capacity of Afterbay diversions during peak periods of peak water supply demands is 4,050 cfs. The Oroville Thermalito Complex has a capacity of approximately 17,000 cfs through the powerplants, which can be returned to the Feather River via the Afterbay's river outlet.

3.2 POWER EXCHANGE

Overall, the SWP uses more energy than it produces. To balance SWP loads with available resources, DWR relies upon a suite of options that include purchases from the Power Exchange, day-ahead, and hour-ahead markets; capacity exchanges; and energy contracts (both short and long-term). Two such contracts with Southern California Edison Company (SCE) allow DWR to exchange on-peak capacity and energy for off-peak energy that may be used elsewhere within the SWP system. Specifically, under the terms of the 1979 Power Contract and the 1981 Capacity Exchange Agreement, DWR provides SCE with up to 350 MW of capacity and approximately 40 percent of the energy from Hyatt-Thermalito. In return, DWR receives off-peak energy from SCE equal to the amount of energy provided to SCE from Hyatt-Thermalito, plus an additional amount of energy as payment for the capacity. The amount of additional energy is determined annually based on the Capacity-Energy Exchange Formula defined in the 1979 Power Contract.

3.3 LOAD MANAGEMENT

The SWP controls the timing of its pumping load through an extensive computerized network. That control system allows DWR to minimize the cost of power it purchases by maximizing pumping during off-peak periods when power costs are lower—usually at night—and to sell power to other utilities during on-peak periods when power values are high. By taking advantage of this flexibility in scheduling SWP pumping load and generation, DWR reduces the net cost for SWP water deliveries.

When generation from the Oroville Facilities exceeds SWP load requirements, DWR sells the excess power on the market. Currently, DWR contracts with utilities and marketers for short-term purchase, sale, or exchange of power. In addition to selling firm power, DWR may sell power on a day-to-day or hour-to-hour basis according to the terms of its interchange agreements and of the Western System Power Pool agreement. These agreements provide the basis for making economy energy transactions, short-term capacity and energy sales or exchanges, unit commitments, and transmission service purchases. Through these contracts, DWR sells excess capacity and energy at market rates.

3.4 ANNUAL GENERATION DATA

Economic hydroelectric generation provides the largest share of SWP power resources. However, hydroelectric generation at the Oroville Facilities is greatly affected by the amount of annual runoff to the Feather River watershed. The combined 762 MW Edward Hyatt Powerplant and Thermalito Pumping-Generating Plant generate about 2.2 billion kWh in a median water year (DWR 1999). The three MW from the Thermalito Diversion Dam Powerplant adds another 24 million kWh a year. Over the past 16 years, the range of generation has varied from below 1,000,000 MW-hours in 1991 and 1992 (critically dry years) to over 3,700,000 MW-hours in 1995 (a very wet year). Figure 3-1 summarizes annual generation at the Oroville Complex for the past 16 years.

Click here to access Figure 3-1

3.5 RESERVOIR OPERATIONS

Lake Oroville can store about 3.5 maf of water at maximum capacity. Figure 3-2 depicts the area and capacity (volume) versus elevation curves for Lake Oroville.

Operations of the Oroville Facilities are planned and scheduled in concert with other SWP facilities. Its waters meet local and downstream demands when unregulated flows alone are not enough to satisfy those needs. It plays an important role in protecting lives and property downstream along the Feather and Sacramento rivers during periods of high flow. In addition, it enables DWR to offset some of the high costs associated with operating the SWP through electrical generation at its powerplants. Operation of the complex varies seasonally, weekly, and hourly depending on hydrology and the objectives that DWR is trying to meet. Typically, releases to the Feather River are managed to conserve water while meeting instream, Sacramento-San Joaquin Delta, and SWP requirements including flow, temperature, fisheries, recreation, water quality, and diversion.

Planning for and implementing the operations of the SWP is highly dependent on constraints placed upon the Oroville Facilities. The SWP's operations decision-making is a stepwise process that begins with an overall plan for the year. This long-range plan is used to establish general operational objectives and to assess the likelihood of achieving these objectives. On a weekly basis, operations are planned that will result in the overall annual objectives being achieved. Daily schedules are developed to achieve the weekly operational objectives and are adjusted in real-time as needed to respond to changes in conditions. The Oroville-Thermalito Complex operational planning is performed within DWR headquarters by the Operations Control Office (OCO). The day-to-day operation of the Oroville Facilities is done through the Oroville Field Division (OFD).

3.5.1 Flood Control Requirements

The Oroville Facilities are an integral component of the flood control system for the surrounding area. During the wintertime, the Oroville Facilities are operated under flood control requirements specified by the U.S. Army Corps of Engineers (USACE). Under these requirements, Lake Oroville is to be operated to maintain up to 750,000 acre-feet of storage space to allow for the capture of significant inflows. Flood control releases are

Click here to access Figure 3-2

determined by the release schedule in the flood control manual and by consultation with the USACE.

The flood control diagram is designed for multiple use of reservoir space. During times when flood control space is not required to accomplish flood control objectives, reservoir space can be used for storing water. Figure 3-3 is an example flood control diagram for October 1, 1999 through December 31, 2000.

From October through March, the maximum allowable storage limit varies from about 2.8 to 3.2 maf to ensure adequate space in Lake Oroville to handle any flood flows. The actual limit is based on a wetness index, computed from accumulated basin precipitation. This allows DWR to maintain Lake Oroville at a higher level when the prevailing hydrology is dry while maintaining adequate flood protection. When the wetness index is high (i.e., wetness in the basin is high), the flood control space required is at its greatest amount to provide the necessary flood protection. From April through June, the maximum allowable storage limit is increased as the potential from flooding decreases to allow capture of the higher spring flows for use later in the year. During September, the maximum allowable storage decreases again to prepare for the next flood season.

Figure 3-4 shows the Lake Oroville water levels for dry, average and wet water years. As seen in the figure, the shape of the actual operations follows the shape of the flood control diagram with:

- lower levels in the late winter and early spring for flood control purposes;
- higher levels in the late spring early summer as the higher flows are stored; and
- declining levels in the late summer and fall as the stored water is used.

Click here to access Figure 3-3

Click here to access Figure 3-4

The maximum allowable storage limits can be violated during flood events to prevent downstream flooding along the Feather River. Table 3-1 lists the maximum allowable flows at various locations along the Feather River.

Table 3-1: Maximum Feather River Flow Rates

Location	Max. Allowable Flow
Below Lake Oroville	150,000 cfs
Above Yuba River	180,000 cfs
Below Yuba River	300,000 cfs
Below Bear River	320,000 cfs

Table 3-2 presents the significant spills of record. The maximum release (excluding flows through the Edward Hyatt Powerplants) of 137,000 cfs is considerably below the peak inflow of 266,000 cfs associated with that release. The largest total release of over 2 maf occurred in 1996.

Table 3-2: Significant Spills of Record

Spill Begin	Period End	Maximum. Release in cfs	Total Release in af	Maximum Inflow in cfs
1-13-70	2-02-70	59,000	1,563,621	34,600
1-12-80	1-20-80	70,000	726,259	155,200
2-15-86	3-01-86	137,000	1,420,262	266,000
3-09-95	3-27-95	80,000	1,234,672	140,647
12-27-96	1-17-97	130,000	2,013,300	276,578

3.5.2 Downstream Requirements

As a major exporter of water from the Delta, the SWP must balance the water demands of its contractors with maintenance of the Delta's water quality requirements. To meet water contractor demands, water must be moved from Oroville into the Feather and Sacramento rivers and ultimately into the Delta. It takes approximately three days to move water from Oroville to the Delta and the amount moved depends on the time of year, export levels, and at times real time water quality conditions.

3.5.3 Annual Operations Planning

Operations planning requires a high degree of coordination with other agencies and must consider many factors. The OCO develops an annual operations plan that considers forecasted water supply, projected operations of the Central Valley Project, and regulatory (flood control, instream requirements, and water quality) and contractual obligations. The first official plan is completed in early December of each year as part of the “allocation process” and is a significant component in determining the amount of forecasted deliveries to state water contractors. This monthly time-step plan includes projected release to the Feather River, forecasts of Oroville inflow, Lake Oroville end-of-month storage, and local demands. The plan is updated each month through April to reflect changes in hydrology and downstream operations.

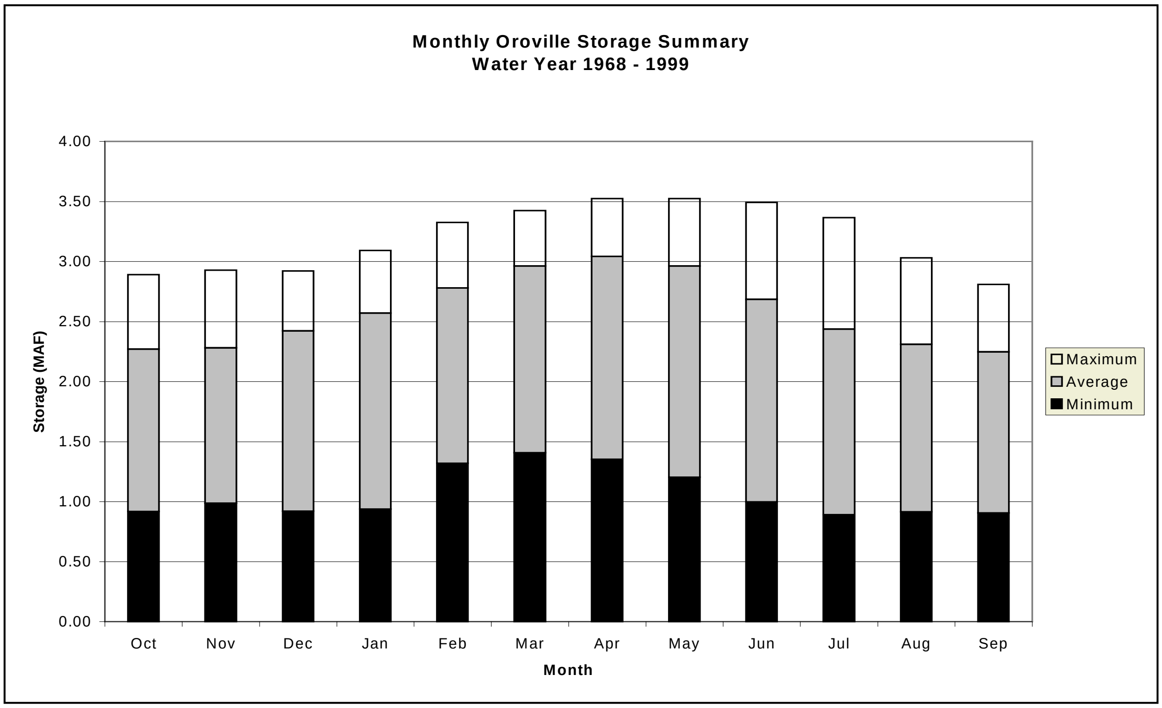
Figure 3-5 shows the minimum, average, and maximum mean monthly Oroville storage for water years 1968 to 1999. The difference in storage levels for any given month is indicative of the variability of hydrology and the effect that it has on annual operations planning. Typically, Lake Oroville is filled to its maximum annual level of up to 900 feet msl in June and then lowered as necessary to meet downstream requirements to its minimum level in December or January. During drier years, the lake may be drawn down more and may not fill to the desired level the following spring. For example, during 1991, 1992, and 1993, the minimum elevations were 651 feet, 702 feet, and 723 feet, respectively.

As part of the allocation process, not all of the forecasted Oroville storage is utilized during the current year’s operation. It is assumed that only half of the available Lake Oroville storage above the minimum pool is used and the remaining half is stored for use in subsequent years. This ensures there will be some water to met the operational needs of the SWP in subsequent years in case of consecutive dry years.

3.5.4 Weekly Operations Planning

Each week, the OCO develops a general plan for reservoir releases. This plan considers how much water will be needed downstream for: (1) local demands; (2) SWP pumping requirements in the Delta; (3) Delta water quality and quantity requirements; (4) instream flow and temperature requirements; and (5) minimum flood control space. The weekly plan is revised as needed to respond to changing operational conditions both upstream and downstream.

Figure 3-5



3.5.5 Daily Operations Scheduling

On a daily basis, hourly releases through the powerplants are scheduled. The hourly operation through the plants is planned to maximize the amount of energy that may be produced during periods when electrical use is highest (and most costly). Additionally, ancillary services required for participation in the electric utility market and bid into the California Independent System Operator (CAISO) are also scheduled on an hourly basis. These services include spinning reserve, non-spinning reserve, supplemental energy market, and regulation. The hourly schedule may be manipulated in any fashion as long as it meets the overall daily Feather River release objective downstream of Thermalito Afterbay.

3.5.6 Thermalito Diversion Dam Pool

The Thermalito Diversion Dam Pool is the tailwater pool for the Edward Hyatt Powerplant and acts as a forebay when the powerplant is being utilized to pump water back into Lake Oroville. Water is diverted from the Diversion Dam Pool into the

Thermalito Power Canal for power generation at the Thermalito Pumping-Generating Plant. Additional water is diverted from the Thermalito Diversion Dam Pool into the natural channel of the Feather River where the water eventually flows to the Fish Barrier Dam and the Feather River Fish Hatchery.

3.5.7 Thermalito Forebay and Afterbay

The Thermalito Forebay is utilized to convey generating and pumping flows between the Thermalito Power Canal and the Thermalito Pumping-Generating Plant. The forebay additionally provides regulatory and surge damping for the Hyatt-Thermalito Power Complex for pumping and generating operation. Both the Forebay and Afterbay reservoirs are too small for seasonal storage so they are used primarily in weekly and daily operations planning.

The Thermalito Afterbay provides storage for pump-back operations; water used to generate electricity in excess of what is needed to meet downstream requirements can be pumped back into Lake Oroville during periods when energy prices are low. The afterbay also provides the means to maintain uniform flow in the Feather River downstream of the Oroville-Thermalito Facilities. It is also used to furnish water to local water districts in the Oroville area. All of these requirements must be taken into consideration when developing daily schedules for the Hyatt-Thermalito Powerplants.

Generally, the Hyatt-Thermalito Powerplants are operated to maximize the generation operation during the weekdays when power prices are highest. This usually results in higher storage in the afterbay by the end of the week. Generation at the Hyatt-Thermalito Powerplants is then decreased over the weekend, lowering the elevation of the afterbay, which prepares it for a similar operation the next week.

The Power Canal conveys flows between the Diversion Dam Pool and the Thermalito Forebay for operations at Thermalito Pumping-Generating Plant. Flow direction depends on whether the complex is being operated in pumping or generating mode. The Power Canal was designed to convey a maximum of 16,900 cfs for the generating cycle of pumped storage operation. Maximum flow in pump cycle is approximately 9,000 cfs.

3.5.8 Fish Barrier Dam Pool

Because of the relatively constant discharge of 600 cfs into the Fish Barrier Dam Pool from the Thermalito Diversion Dam Powerplant, the Fish Barrier Dam Pool remains at a stable pool elevation. A notable exception to this is during periods of spill releases, when flood flows are routed through the Fish Barrier Dam Pool.

3.6 FLOW AND TEMPERATURE REQUIREMENTS

Minimum flows in the Lower Feather River are established by a 1983 agreement between DWR and DFG, Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife. The agreement establishes criteria for flow and temperature for the Low Flow Channel of the Feather River and the reach of the Feather River below the Thermalito Afterbay outlet to the confluence with the Sacramento River for preservation of salmon spawning and rearing habitat.

The agreement specifies that DWR release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fishery purposes. This is the total volume of flows from the diversion dam outlet, diversion dam powerplant, and the Feather River Fish Hatchery pipeline.

Table 3-3 lists the major minimum in-stream flow requirements on the Feather River below the Thermalito Afterbay return to the Feather River.

Table 3-3: Feather River Minimum Flow Requirements (1)

Percent of Normal (2) Runoff (%)	Oct – Feb (cfs)	Mar (cfs)	Apr – Sep (cfs)
> 55	1,700	1,700	1,000
< 55	1,200	1,000	1,000

(1) If Oroville surface elevation is greater than 733 feet.
(2) Normal is defined as the mean (1911 – 1960) April through July unimpaired runoff near Oroville of 1,942,000 acre-feet.

There is a requirement that if during October 15 through November 30 the hourly flow is greater than 2,500 cfs then the flow minus 500 cfs must be maintained until the following March unless the high flow was due to flood control operation or mechanical problems. This requirement is to protect any spawning that could occur in overbank areas during the higher flow rate by maintaining flow levels high enough to keep the overbank areas submerged. In practice, the flows are maintained below 2,500 cfs from October 15 to November 30 to prevent spawning in the overbank areas.

The agreement also specifies a narrative objective for water temperature below the Thermalito Afterbay river outlet and a numerical objective for temperatures of water provided to the Feather River Fish Hatchery. Below the Afterbay river outlet, temperatures must be suitable for fall-run salmon during fall months (after September 15). From May through August, temperatures must be suitable for shad, striped bass, and other warmwater fish. Under the agreement, the water supply for the Feather River Fish Hatchery must adhere to the following water temperature objectives (a deviation of plus or minus 4F° is allowed between April 1 through November 30):

Table 3-4: Water Temperature Objectives

Period	Temperature (°F)
April 1-May 15	51º
May 16-May 31	55º
June 1-June 15	56º
June 16-August 15	60º
August 16-August 31	58º
September 1-September 30	52º
October 1-November 30	51º
December 1-March 31	55º

Meeting the water temperature criteria is facilitated by a shutter controlled intake gate system at the dam that selects water for release from various reservoir depths, depending on the desired water temperature. Note that the National Marine Fisheries Service (NMFS) is proposing a new set of water temperature objectives that would provide colder water downstream for protection of steelhead and spring-run chinook salmon.

In addition to fish and wildlife obligations, a May 1969 agreement between DWR and Joint Water Districts obligates DWR to provide water at temperatures reasonably related to achieving agricultural production within the Joint Water District service area. Local rice farmers, whose interests are represented under the 1969 agreement, need warmer water during spring and summer for germination and growth of the rice (i.e., 65ºF from approximately April through mid-May, and 59ºF during the remainder of the growing season [Robbins, DWR, pers. comm., 2000]). DWR accommodates these farmers by releasing water that is as close as possible to the maximum temperature allowable under the DFG-DWR agreement (i.e., 4ºF higher than the objectives stated above). Farmers often pond the water before flooding the rice fields to attain the desired water temperature.

3.7 PROPOSED OPERATIONAL CHANGES

At this time, no operational changes are proposed to the project; however, changes may be implemented as a result of the relicensing process.

4.0 AFFECTED ENVIRONMENT

4.1 GENERAL SETTING OF THE FEATHER RIVER WATERSHED

4.1.1 Landscape Setting

The Central Valley basin includes two major river basins – the Sacramento River on the north, and the San Joaquin River on the south (USBR 1970, 1975 cited in DWR 1993). The Sacramento and San Joaquin rivers unite at the Sacramento-San Joaquin Delta; from the Delta, the waters of both rivers flow to the San Francisco Bay and from there to the Pacific Ocean. The Sacramento River contributes roughly 85 percent of the Delta inflow in most years, while the San Joaquin River contributes about 10 to 15 percent.

The Feather River is a major tributary to the Sacramento River, making up about 25 percent of Sacramento River water[3]. The Feather River has a drainage area of about 5,900 square miles (Figures 4.1-1 and 4.1-2). Originating in the volcanic formations of the Sierra Nevada, the Middle and South Forks formerly joined 5.4 river miles above Oroville Dam and were joined by the North Fork three river miles below their confluence. Their confluence is now Lake Oroville. The Yuba River joins the Feather River near the City of Marysville, 39 river miles downstream of Oroville (Figure 4.1-2). The confluence with the Bear River is 16 river miles downstream of Marysville.

On the Feather River, the SWP's Lake Oroville controls potential floodwaters, conserves water for release downstream, stores water for power generation, and provides recreation opportunities. From the Fish Barrier Dam near the Feather River Fish Hatchery, the Feather River flows south about 67 river miles before emptying into the Sacramento River near Verona about 21 river miles above Sacramento.

The Feather River watershed is located at the north end of the Sierra Nevada mountain range. The watershed is bounded by the volcanic Cascade Range to the north, the Great Basin on the east, Sacramento Valley on the west, and higher elevation portions of the Sierra Nevada on the south. The upper Feather River watershed is approximately 3,611 square miles in size. The upper Feather River watershed (i.e., the drainage area above the gauging station at Oroville) is 3,624 square miles and encompasses about 68 percent of the Feather River basin. The rest of the basin extends south and includes the drainage of

[3] The percentage of the Sacramento River that is the Feather River was calculated based on flow records from 1906-1995 for the Sacramento River Index and the Feather River at Oroville.

Click here to access Figure 4-1

Click here to access Figure 4-2

the Yuba and Bear rivers. Of the Feather River's total flow, 75 percent originates above Oroville, about half of which comes from the North Fork.

The upper watershed is ruggedly mountainous, bisected by deep canyons in the western third of the watershed. The central third of the watershed is a transition zone consisting of broad alluvial valleys surrounded and separated by high, steep peaks and ridges. The headwater areas of the eastern third consist of long, broad meadow systems separated by relatively low ridges. Elevations range from 922 feet at Oroville Dam crest to over 10,400 feet on Mount Lassen. The major tributaries to the Feather River (including the South Fork, East Branch North Fork, North Fork, and Middle Fork) generally flow from east to west.

4.1.2 Climate

Climate in the region follows a Mediterranean pattern, with cool wet winters and hot dry summers. Temperatures range from below zero to above 100ºF. Approximately 95 percent of the annual precipitation occurs during the winter months. Precipitation ranges from 33 inches at Oroville to over 90 inches at the orographic crest near Bucks Lake to less than 20 inches in the eastern headwaters. Precipitation above 5,000 feet occurs primarily as of snow, which regularly accumulates in excess of five to ten feet in winter. Summer thunderstorms occur infrequently, predominantly in the eastern third of the watershed. These storms can produce significant rainfall of short duration over a relatively small area.

4.1.3 Vegetation

The principal vegetative community in the western and central portions of the watershed between 2,500 and 6,000 feet in elevation is mixed conifer (sugar pine, ponderosa/Jeffrey pine, incense cedar, Douglas-fir, and white fir). Higher elevations are red fir dominated. The majority of the conifer forestlands, both private and public, have been harvested for timber to some degree. Oak woodland is the dominant vegetative community below 2,500 feet elevation. The eastern third of the watershed is predominantly eastside pine with juniper/sage prevalent on drier sites. The once extensive wet meadow systems present in the eastern portion of the watershed have been reduced to a few relic reaches due to system-wide channel incisement. The sedge/perennial grass/willow communities of these formerly wet meadows/valleys have converted to sparse sage/annual grass vegetation due to dewatering.

4.1.4 Land/Water Use

Approximately 70 percent of the watershed is in federal ownership (primarily U.S. Forest Service [USFS]) and managed for multiple uses. Principal land use activities on federal land include recreation, silviculture, hydropower generation, and livestock grazing. Private lands are managed for timber production, agriculture (hay production), livestock grazing, and residential uses. Most of the population occurs in several small communities centered on larger alluvial valleys including Chester, Quincy, Greenville, and Portola. The North Fork Feather River canyon serves as a major east-west transportation artery (Union Pacific Railroad and State Highway 70). The Feather River (principally the North Fork Feather River) has extensive hydropower generation development, producing over 1,750 MW of electricity. Approximately 45 miles of the Middle Fork Feather River are designated as a Wild and Scenic River from Sloat, California to within 1.5 miles of Lake Oroville.

The mean annual discharge of the upper Feather River watershed is in excess of 2.7 million acre-feet. These waters are used for a variety of beneficial uses including recreation, cold-water aquatic habitat, and hydropower generation, irrigation, and domestic and municipal water supply. The Feather River watershed generally contains water of excellent quality. However, localized concentrations of mercury and polychlorinated biphenyls (PCBs) have been identified. Non-point source sediment is considered the primary water quality impairment. Pacific Gas & Electric Company (PG&E) estimates that 2,700 acre-feet of sediment were deposited behind Rock Creek Dam during a 34-year period. DWR has actively worked as a member of the Feather River Coordinated Management Group to identify and treat non-point source sediment problems within the watershed since 1986.

4.1.5 Watershed Resource Issues

Several over-arching resource issues have been identified in the Feather River watershed by federal, state, and local agencies, as well as the community at large. Water quality and timing of flows have been significantly influenced by 150 years of resource use. These issues are being addressed through an ongoing program of watershed restoration undertaken by the 15-year old Feather River Coordinated Resource Management Group (FR-CRM), of which DWR is a participating member. The threat of catastrophic forest fire, exemplified by two 40,000+ acre fires in the past two years, is being addressed through the Quincy Library Group (QLG). The QLG effort focuses on USFS-managed lands within the watershed and advocates removing smaller diameter timber from overstocked forests to reduce the occurrence of uncontrollable crown fires.

The FR-CRM has identified the functional loss of water retention on a watershed scale as the major contributing factor to accelerated erosion/sedimentation, aquatic and terrestrial habitat loss, and chronic flooding. The FR-CRM restoration focus has shifted from a reach-long channel stability project in the middle watershed to channel/meadow restoration in the upper watershed. This primarily entails reconnecting the incised channels to their naturally evolved floodplain/meadows using a variety of techniques tailored to the individual site. Restoring floodplain function allows for spreading overbank flows onto well-vegetated floodplains, which retards the speed of flows down the watershed. With some meadow systems contiguous for 30+ miles, this retardance can have a significant influence on the timing and magnitude of peak stages downstream. The meadows also absorb and retain a portion of the winter precipitation for augmentation of late season flow through bank recharge. The combination of sediment control through the reduction in on-site erosion, filtering of upper watershed sediments via floodplain vegetation, and the reduction in erosion stress on downstream channels from altered peak flows provides system-wide benefits for all aquatic- dependent biota.

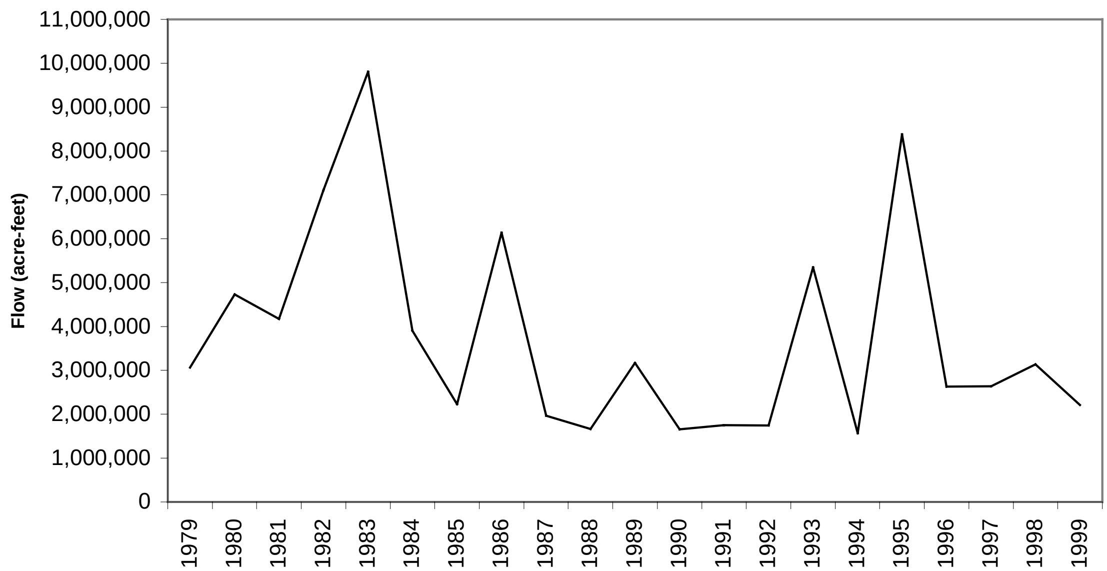
4.2 WATER QUANTITY AND USE

4.2.1 Water Quantity

The average unimpaired flow of the Feather River at Oroville is about 5,800 cfs (4.2 maf). Much of the runoff occurs in the January through June period from both rainfall and snowmelt. Typically, unimpaired runoff exceeds 2,000 cfs (4,000 AF/day) during this period. Summer inflows are sustained at about 1,000 cfs by snowmelt runoff and groundwater accretions from the high elevation watersheds. Upstream reservoirs contribute some seasonal storage, which reduces runoff in spring and increases flow in summer and fall. Due to several small diversions upstream, actual average annual inflow is about 4.0 maf (CALFED 2000).

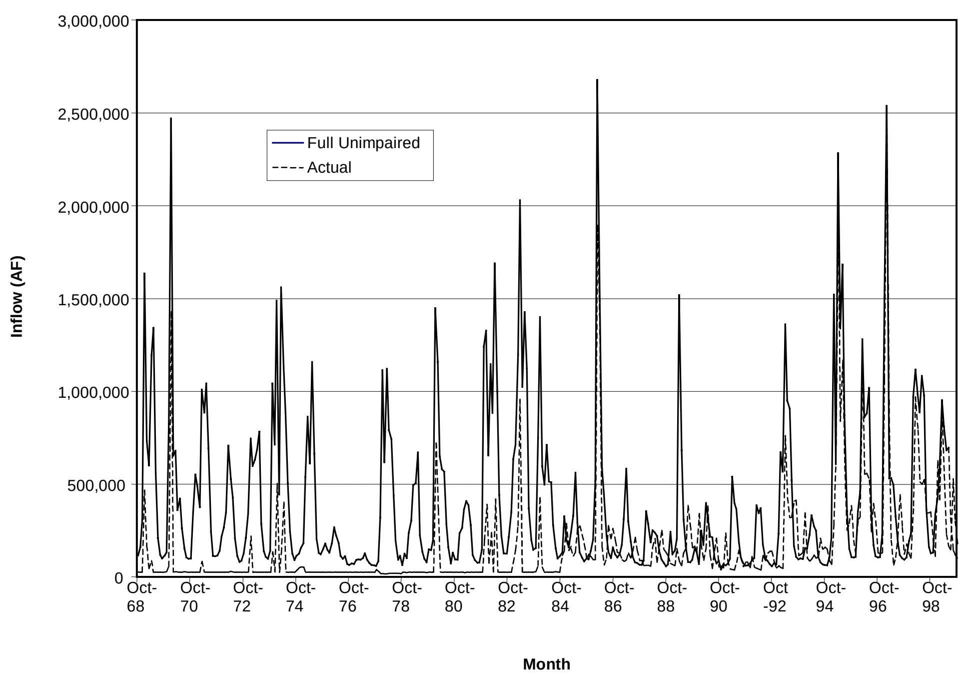
Annual flows are variable and depend upon annual precipitation. From 1979 to 1999, annual inflows have ranged from a minimum of 1.7 maf to as high as 10 maf (Figure 4.2-1). Figure 4.2-2 presents the monthly Oroville inflow and Figure 4.2-3 presents the flow duration curve based on daily inflows. The full unimpaired inflow shown on Figure 4.2-2 is the inflow to Lake Oroville that would have occurred if there were not upstream storage or diversion operations. The actual inflow is the inflow that occurred after all

Figure 4.2-1 Total Annual Inflow into Lake Oroville from 1979-1999



Data source: Dibbens 2000, personal communication; See Notes

Figure 4.2-2: Monthly Oroville Inflow



Click here to access Figure 4.2-3

upstream operations. As the data in the figure indicate, there are many periods where the computed full unimpaired inflow to Lake Oroville is considerably higher that the actual inflow. This is due to upstream storage and/or diversion of flows that otherwise would have flowed into the reservoir. This figure also shows the differences in inflow to Lake Oroville both from month to month within a year and from year to year.

Outflow from the project typically varies from spring seasonal highs to about 3,500 cfs (7,000 AF/day) in November (Figure 4.2-4). Although the Edward Hyatt and Thermalito Pumping-Generating Plants operate in a peaking mode, flows in the Feather River are held relatively constant via the Thermalito Afterbay Outlet works.

4.2.2 Water Use

In the past, substantial irrigation diversions were made from the Feather River in the vicinity of Oroville. These diversions are now made from the Thermalito Complex. The maximum monthly diversions from Thermalito (approximately 150 thousand acre-feet) are made during the May through August irrigation season (Figure 4.2-5). Annual Thermalito diversions are slightly less than 1 maf, leaving about 3 maf for flow in the Feather River downstream of the project. Discharges into the lower Feather River continue into the Sacramento River and into the Sacramento-San Joaquin Delta. At the north end of the Delta, the water is pumped into the North Bay Aqueduct. In the south Delta, water is diverted into Clifton Court Forebay where the water is stored until it is pumped into the California Aqueduct. Additionally, flows through the Delta are maintained to meet Bay-Delta water quality standards.

4.3 GEOLOGY

4.3.1 Watershed Geology

The 3,600 square mile watershed above Lake Oroville lies in portions of the foothill and mountain regions of the northern Sierra Nevada and the southern Cascade ranges. Primary rock types are granitic, volcanic, metamorphic, and sedimentary ranging in age from Ordovician to Recent. The chief structural features are the Foothills fault system, consisting of parallel faults oriented roughly southeast-northwest, and the Honey Lake escarpment on the eastern edge. Over 5000 feet of uplift has occurred along the escarpment from the Pliocene to the recent time.

Click here to access Figure 4.2-4

Click here to access Figure 4.2-5

In the upper one-third of the watershed, streams historically flowed in shallow meandering channels with broad floodplains covered with riparian vegetation. Floodwaters would quickly overtop the banks and deposit sediment on the valley floor. Under current conditions, land use changes have caused many of the headwater streams to lose their meander patterns and form into sharp V-shaped channels devoid of vegetation. The tall alluvial banks along these channels are easily eroded. Much restoration work has been done to re-stabilize these streams in the past 15 years.

In the lower two-thirds of the basin, the West Branch, North, Middle, and South Forks flow in deeply incised canyons with little or no floodplain. Below Lake Oroville, the Feather River joins with the Yuba River and flows across the Sacramento Valley to join the Sacramento River at Verona.

4.3.2 Faulting And Seismicity

In the eastern part of the basin, the dominant structural feature is a series of roughly parallel normal faults, resulting from extensional tectonic forces. This structural regime is related to the adjacent Basin and Range Province to the east. Displacement along these faults has created a series of down dropped broad alluvial valleys bounded by ridges. The greatest magnitude historic seismic event here occurred on an unnamed fault near Portola at a magnitude 5.6 in 1959.

The dominant faulting on the west side is a series of northwest trending and east dipping reverse faults called the Foothills fault system. These faults were formed during the late Jurassic but have been reactivated in the late Cenozoic and are believed active today. Several of these faults pass through the reservoir area. Historic seismicity here include a magnitude 5.7 on August 1, 1975, southeast of Oroville, a 4.6 on May 24, 1966 near Chico, and a 5.7 on February 8, 1940 some 20 miles east of Chico.

DWR (February 1979), in The August 1, 1975 Oroville Earthquake Investigations, concluded the following:

- The August 1, 1975, Oroville earthquake was accompanied by movement on the previously unrecognized Cleveland Hill Fault. A linear zone of discontinuous ground cracking developed along the fault about 4.3 miles east of the main shock epicenter;

- Most Cenozoic fault movements in the Sierran foothill belt are caused by east-west extensional stresses reactivating pre-existing Paleozoic and Mesozoic faults;
- The level of seismic activity is one of low – to moderate-magnitude earthquakes at relatively long recurrence intervals, occasionally resulting in minor ground rupture and offset; and
- The available evidence does not indicate a causal relationship between Lake Oroville and the earthquake, but the possibility cannot be eliminated conclusively at this time.

4.3.3 Sediment Yields

4.3.3.1 Landslides

Landslides occur in a variety of rock types. Large ancient landslides are common around Lake Oroville, mostly in metamorphic rocks. Landslides also occur on the North and Middle Forks. The combination of steep topography and steeply dipping, highly faulted, thin-bedded and weakly metamorphosed sediments in a seismically active area indicates a serious landslide risk in some areas of the watershed. During intense precipitation, numerous landslides are typically activated, resulting in a large increase in the river sediment load.

Landslides are a major source of sediment. The western part of the watershed is most sensitive, particularly the canyons of the Feather River and Indian, Spanish, and Eureka creeks. Pre-historic landslides large enough to temporarily block the North Fork have occurred. Failures are mostly within volcanic and metamorphic rocks. Some landslide toes are now inundated by Lake Oroville. Several smaller failures along the toe of these large landslides occur, indicating that these features may be reactivated. A large dormant landslide (about three square miles in area) occurs on the north slope of Bloomer Hill, in the North Fork arm of Lake Oroville (DWR, November, 1994, North Fork and Middle Fork Feather River Watershed Report). The toe has recently been reactivated in places. Catastrophic failure of this landslide, while unlikely, could possibly affect the safety and operation of Lake Oroville.

4.3.3.2 Erosion Hazards

Parts of the watershed produce high sediment yields. Historically, cumulative effects of human activity and resource use have destabilized the watershed and promoted accelerated erosion and sedimentation. Accelerated erosion and sedimentation have been observed in the watershed for several generations. A U.S. Soil Conservation Service (SCS) report, The East Branch North Fork Feather River Erosion Inventory Report (1989), estimated that 90 percent of the erosion in a 1,200 square mile study area was accelerated erosion caused by human activities. Accelerated erosion is a soil loss rate greater than soil loss occurring under natural conditions. High sediment yields can reduce the reservoir capacity, degrade water quality, and harm fish and wildlife.

4.3.3.3 Reservoir Sedimentation

The construction of Lake Almanor in 1913 stopped most of the sediment derived from the upper part of the North Fork Feather River. No reservoir sedimentation data could be found for Lake Almanor. Post-Almanor bedload material sources have been the East Branch, other tributaries, and bank erosion. Large quantities of sand and silt enter the North Fork from the East Branch. These sediments accumulate in pools, on point bars, and behind dams.

High sediment yields have significantly impaired storage capacity and hydroelectric operations in several PG&E reservoirs upstream of Lake Oroville on the North Fork Feather River. Storage in Rock Creek Reservoir has been reduced to 46 percent of its original capacity, and Cresta Reservoir has been reduced to 56 percent capacity. PG&E is working on reservoir and dam modifications to allow the sediment to flow through these reservoirs. The sediment would then move downstream into Lake Oroville. Typical of dammed rivers, stream channels below the reservoirs have become depleted in gravel and sand sizes and armored by cobbles and boulders.

DWR (October 1994, 1993-1994 Lake Oroville Siltation Study) measured sediment deposition in Lake Oroville and concluded that about 15 feet of sediment deposition has occurred, for a total volume of 18,000 acre-feet of deposition.

4.3.3.4 Reservoir Erosion

Several landslides occurred around the periphery of the reservoir during the first few years of operation following initial filling. Most were minor and have since generally stabilized (DWR 2000).

4.3.3.5 Mining Legacy

Mining in the watershed began in the mid-1800s and continues today, although on a smaller scale. Mineral resources include gold, copper, manganese, silver, chromite, lead, limestone, sand and gravel, and rock. The first miners exploited placer gold deposits in stream gravel. Gravel was dredged and sluiced to separate the gold. Between the 1850s and 1890s, hydraulic mining using high pressure water jets to erode older gold-bearing formations washed large amounts of sediment into the stream system. Much of this gravel deposited at the mouth of the Feather River Canyon below Oroville Dam. Mercury, used to amalgamate with the gold in the sluices, is still a significant pollutant in some places below the dam.

Hard rock mining also produced large quantities of pulverized tailings. Many of these tailings now leach sulfides into some of the streams above the lake. This acid mine drainage which lowers stream water pH and contains toxic heavy metals.

4.3.4 Lower Watershed Geology and Geomorphology

Rocks of the Sacramento Valley and adjacent foothills of the lower watershed vary from crystalline basement rocks of the Paleozoic to Mesozoic age, to unconsolidated alluvium of recent age.

From Oroville to Gridley, the floodplain consists of loamy soils underlain by coarse gravel. The floodplain, ranging from two to three miles wide, is flanked by the alluvial uplands. Water Well Complete Reports indicate that the channel of the ancient Feather River was entrenched up to 50 feet into older alluvium and basin deposits.

Much of the surface of the Feather River floodplain near Oroville is covered by the coarse debris of the hydraulic mining era and the mounded remains of dredge tailings that accumulated from 1905-1952, during the second major period of gold extraction. Most of the dredge tailings were later used as borrow material for construction of Oroville Dam, but sinuous ridges of cobbles, boulders, and gravel to 40 feet in height still cover large areas.

From just below Oroville, through the tailings area, the river channel is defined by cobble levees that restrict overbank flooding and provide lateral channel control. The channel bed also consists of coarse gravel and cobbles. Downstream from the influence of the coarse gravel in the dredge and borrow areas, the channel bed and banks become more variable, as the river begins to flow through undisturbed older alluvium and floodplain deposits.

4.3.4.1 Channel Degradation and Loss of Overbank Sediment

Construction of dams has had numerous effects on downstream river channels. In regards to the transport of sediment, dams capture all bedload and virtually all suspended loads upstream of the dam. Thus, water released into the downstream channel is void of sediment. Degradation of the channel is a common response.

To maintain minimum flow and control possible flooding events, Oroville Dam's regulation of the discharge has dampened low and high flow events downstream. The lack of overbank flooding halts natural sedimentation but continues to cause channel degradation. Sediment-free flow below the dam scours the river channel and transports all but the coarsest sediment. The resulting substrate is armored by cobbles and boulders.

Oroville Dam has prevented recruitment of spawning size gravel to riffles since the 1960s. Riffles continue to degrade as floodflows move gravel downstream without replenishment from areas above. Gravel degradation can reduce spawning success. In riffles with large numbers of returning salmon and limited spawning gravel, fish spawn on top of each other's redds, reducing spawning success.

4.3.4.2 Post Dam Changes in Bank Erosion, Meandering, and Floodplain Processes

Rivers are composed of three primary building blocks – various sizes of sediment, varying amounts and stages of vegetation, and varying amounts of water. The interaction of these building blocks is very complex and interdependent. These parameters together result in the geomorphic environment and can provide a diversity of physical structures, such as point bars and pool-riffle sequences, that perform a variety of environmental functions.

Varying flows impart varying amounts of energy throughout a river channel and elicit varying responses in the river channel. Flows can mobilize and deposit a wide range of sediment particle sizes. This movement and deposition of sediment particles in turn scours and shapes the river channel, creating river bars, pools and riffles, and can force the channel to shift laterally along the floodplain.

Oroville Dam has affected this process by capturing the majority of the winter storm flows. The attenuated peaks do not have the same stream power to move bedload, erode banks, or cause meandering. The reservoir also captures the sediment that would normally deposit on the floodplain.

4.3.4.3 Groundwater Seepage and Water Levels

The Thermalito Afterbay was constructed on permeable geologic material, resulting in water seeping into the local groundwater basin. Pumps have been installed to move the water back into the reservoir. It is not known whether there is a balance between the seepage and the pumping.

4.4 WATER QUALITY

Water quality in Lake Oroville is affected by that in tributary streams, of which the North, Middle, and South Forks of the Feather River contribute the bulk of the inflow to the reservoir. The quality of water released from Oroville Dam determines water quality downstream in the Feather River, which subsequently determines water quality following diversion to the Thermalito Forebay and Thermalito Afterbay. Water released back to the Feather River at the Thermalito Afterbay river outlet is influenced by passage through the forebay and afterbay.

Water quality at the Oroville Facilities is monitored at stations established at the North, Middle, and South Forks of the Feather River; the river near the dam; the Thermalito Power Canal; and the Thermalito Afterbay. Several additional stations have also been established to monitor water temperatures, including the Feather River at the U.S. Geological Survey (USGS) Gaging Station near the dam, Feather River Fish Hatchery, outlet of the Thermalito Afterbay to the Feather River and irrigation canals, and the Feather River at Robinson Riffle. DWR also operates a network of approximately 20 electronic thermisters in the Feather River downstream of the Oroville Dam.

4.4.1 Water Quality in the Upper Feather River

Water quality data were generally collected bimonthly by the Northern District of the DWR from the North, Middle, and South Forks of the Feather River upstream from Lake Oroville from January 1992 to May 1997. Data collected include field parameters (conductivity, water temperature, dissolved oxygen (DO), pH, turbidity, and alkalinity); nutrients (total ammonia and organic nitrogen, nitrate plus nitrite, ortho-phosphate, and total phosphorus); minerals (calcium, magnesium, sodium, potassium, sulfate, and chloride); and metals (arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, selenium, and zinc). Only field parameters were measured from June 1997 through July 2000. Beginning in August 2000, quarterly analyses have been performed for field parameters, nutrients, minerals, and low levels of metals.

Water temperatures have been measured with temperature recorders at these stations since September 1995. Benthic macroinvertebrates were collected from the North and Middle Forks in September 1995.

4.4.1.1 Field Parameters in the Upper Feather River

Data collected from the North, Middle, and South Forks of the Feather River indicate that DO, pH, conductivity, temperature, and turbidity levels have generally been within the established goals and criteria (see Appendix A).

Minimum DO values were 9.0 mg/L in the North Fork, 8.8 mg/L in the Middle Fork, and 9.4 mg/L in the South Fork (Table 4.4-1). The lowest DO levels in all three rivers were found during summer months.

The pH values have ranged from 7.3 to 8.3 for the North Fork, 7.4 to 8.4 for the Middle Fork, and 7.0 to 7.3 for the South Fork. The lowest pH values are associated with late winter and spring runoff, while the higher pH values are associated with late summer low flow conditions.

Conductivity values in the North Fork, which have ranged from 60 to 138 µmhos/cm, do not exceed the Basin Plan objective of 150 µmhos/cm. However, during late fall and early winter periods, conductivity in the Middle Fork has exceeded the Basin Plan goal with levels ranging as high as 181 during the late fall periods. The Basin Plan objectives do not apply to the South Fork, where conductivity values have ranged from 34 to 54 µmhos/cm.

Recorder data indicate that natural water temperatures in the North and Middle Forks peak at nearly 75ºF during mid-August to early September, and then cool rapidly. Minimum recorded temperatures are generally greater than 35ºF, but occasionally dip lower. Little thermograph data are available for the South Fork since a recorder was only

Table 4.4-1: Range of Field and Laboratory Data from the Upper Feather River

(mg/l except as noted)

	N. F. Feather River at Pulga		M. F. Feather River nr Merrimac		S. F. Feather River at Miners Ranch Canal	
	Minimum	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Miscellaneous						
Dissolved oxygen	9	12.9	8.8	13.1	9.4	12.9
pH	7.3	8.3	7.4	8.4	7	7.3
Conductivity (μmhos/cm)	60	138	56	181	34	54
Alkalinity	24	70	28	94	12	42
Turbidity (NTU)	0.4	60	0.12	60	0.5	14
Nutrients						
Ammonia & organic nitrogen	<0.1	0.8	0.1	1.2	<0.1	1.1
Nitrate & nitrite	<0.1	0.3	<0.1	0.2	<0.1	0.1
Ammonia	<0.01	0.1	<0.01	<0.01	<0.01	0.01
Ortho-phosphate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total phosphorus	<0.01	0.14	<0.01	0.09	<0.01	0.01
Minerals						
Calcium	5	25	6	20	3	5
Magnesium	< 1	15	2	6	1	3
Sodium	1	9	1	9	1	3
Potassium	0.8	2	0.7	2	0.4	0.9
Sulfate	< 1	13	1.6	10	0.8	2
Chloride	< 1	4	1	4	1	2
Boron	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hardness	22	62	44	74	12	18
ASAR		0.5		0.6		0.2
Metals						
Arsenic	<0.001	0.838	<0.001	0.6	<0.001	0.134
Cadmium	<0.001	0.003	<0.001	0.004	<0.001	0.001
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	<0.003	5.2	0.07	5.6	0.06	1.2
Lead	<0.003	0.06	<0.003	0.003	<0.003	<0.003
Manganese	<0.02	0.17	<0.02	0.14	0.02	0.13
Mercury	<0.0004	0.00058	<0.0004	0.00074	<0.0004	0.00057
Molybdenum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Zinc	<0.01	0.04	<0.01	0.02	<0.01	0.02
Benthic Macroinvertebrates						
Number of individuals/sq. ft		1210.8		690.3		
Number of species		41		47		
Diversity index		0.92		1.23		
Equitability index		0		0		

recently installed. However, grab sample data indicate that temperature conditions in the South Fork of the Feather River are similar to those in the North and Middle Forks.

Turbidity has usually been at low levels in the North, Middle, and South Forks, with values generally less than 10 Nephelometric turbidity units (NTUs). However, a water sample collected during the winter of 1996 produced turbidity values as high 60 in both the North and Middle Forks. Another sample collected during the winter of 1997 also contained elevated turbidity levels of 35 NTUs in the North Fork. The Middle Fork was not accessible during this period. Turbidity levels in the South Fork were also elevated during these periods, but only ranged to 7.5 and 14 NTUs, respectively.

4.4.1.2 Nutrients in the Upper Feather River

Total phosphorus concentrations from the North, Middle, and South Forks of the Feather River upstream from Lake Oroville have generally been less than the levels considered stimulatory to algal production. The North Fork was the only tributary that exceeded the potentially stimulatory concentrations of total phosphorus, but in only 1 sample collected during the winter of 1996.

Ammonia has been found at very low levels in the North, Middle, and South Forks. The concentrations of ammonia detected are well below the criteria for protection of aquatic life.

Comparison to other water bodies of high and low algal productivity indicates that nutrients in the North, Middle, and South Forks of the Feather River are at low levels. Nutrient concentrations in the tributaries to Lake Oroville are similar to those found in Lake Almanor, which has low algal productivity.

4.4.1.3 Minerals in the Upper Feather River

The relatively low conductivity levels found in the tributaries to Lake Oroville indicate that general mineral concentrations are not excessive. Mineral concentrations were highest in the North Fork and lowest in the South Fork. Boron has not been detected in any of the tributaries. Calculated adjusted sodium adsorption ratios are low, with the highest value of only 0.6 found from the Middle Fork, indicating that waters from the tributaries are well suited for agricultural uses.

4.4.1.4 Metals in the Upper Feather River

Metals were analyzed for total recoverable concentrations, which includes the dissolved fraction. Since the dissolved fraction may comprise a portion of up to the entire total recoverable concentration, any total recoverable analysis that exceeds the dissolved criteria may indicate a possibility of exceeding those criteria.

Total hardness affects the toxicity of many metals. Most published criteria are usually based on a hardness of 100 mg/L but include conversion tables or graphs to determine the appropriate criterion for other hardness values. Lower hardness increases the toxicity of metals to aquatic life and, hence, lowers the criteria for their protection. Hardness for the Feather River tributaries to Lake Oroville ranged up to 62 mg/Lfor the North Fork and 74 mg/Lfor the Middle Fork, but only 18 mg/L for the South Fork.

While most metals analyzed did not exceed criteria for the protection of beneficial uses, a few were occasionally found at concentrations greater than some of the criteria. Reported cadmium concentrations occasionally exceeded the National Toxics Rule (NTR) criterion for total continuous concentration in the South Fork, and both the total continuous and maximum concentrations in the North and Middle Forks. Total iron concentrations detected in the North and Middle Forks exceeded the agricultural goal only in 1 sample collected during the winter of 1996. Concentrations of lead reported from a sample collected during the spring of 1992 from the North Fork exceeded the NTR for total continuous concentration and the hardness adjusted total maximum concentration. The total continuous concentration criterion for lead was exceeded in the South Fork during the winter of 1996. More recent analyses using ultra clean sampling techniques for low levels of metals have identified concentrations of arsenic that exceed the NTR criteria in the North and Middle Forks. In addition, mercury was found in all three tributaries at concentrations an order of magnitude greater than that of the California Toxics Rule (CTR) for protection of drinking water and aquatic organisms for consumption.

Total recoverable concentrations of several metals, including cadmium, iron, lead, manganese, and zinc, that were greater than criteria for the dissolved fraction established in the Basin Plan or CTR may indicate a possibility of exceeding these criteria. Laboratory detection levels for chromium, copper, and mercury were only recently adequate to determine whether concentrations of these metals meet Basin Plan objectives and criteria for protection of beneficial uses.

4.4.1.5 Biological Monitoring in the Upper Feather River

Riffle samples of benthic macroinvertebrates from the North Fork contained over 1,200 organisms per square foot of substrate. The community was represented by a large number of species, with 41 taxa identified. However, the benthic macroinvertebrate community was overwhelmingly dominated by the dipteran *Simulium*, which comprised 86 percent of the total number of individuals. Other dominant species included the caddisfly *Hydropsyche* and mayfly *Baetis*, which respectively comprised only six and three percent of the total population. Dominance by a single species results in a very low diversity value of only 0.9, with an equitability calculated as zero.

The community of benthic macroinvertebrates found in the Middle Fork was also dominated by *Simulium*, which comprised 76 percent of the total number of individuals. *Baetis* comprised nearly 9 percent, and *Hydropsyche* comprised nearly seven percent of the community, which contained 690 organisms per square foot of substrate. Diversity was poor at this site as well, with a value of only 1.2. Equitability was calculated as zero.

Simulium and *Baetis*, and to a lesser extent *Hydropsyche*, are opportunistic species that are capable of rapidly colonizing disturbed habitats. Very few predators were present in the samples, which would allow these opportunistic species to develop such large populations. The substrate available for sample collection was composed of large cobbles and boulders in the North Fork, which may have resulted in over-representation in the sample by *Simulium* whose lifestyle is to cling to large cobbles in rapidly flowing water. The substrate in the Middle Fork was primarily cobbles, which generally provide suitable habitat for a large variety of species. Several metals at relatively high concentrations in the streams may have adversely affected the benthic communities.

4.4.2 Lake Oroville Water Quality

Lake Oroville is the second largest reservoir in California, typical of many other deep, steep-sided, California foothill reservoirs with large surface fluctuations and a low surface-to-volume ratio. It is a warm, monomictic reservoir that thermally stratifies in the spring, destratifies in the fall, and remains destratified throughout the winter. Stratification begins in April, as lake surface temperatures warm to the mid 50s. A thermocline is typically formed by late May from 16 to 40 feet deep, with surface epilimnetic temperatures at about 72ºF, and the deeper hypolimnetic water at about 52ºF. The thermocline continues throughout the summer, deepening by several feet, and does not begin to break down until September. During October and November, Lake Oroville is actively destratifying and reaches a virtual isothermal state by the end of December at about 50ºF. A typical annual temperature profile is displayed in Figure 4.4-1.

The reservoir elevation can fluctuate more than 100 feet during the course of a normal year, with 250 feet the most it has ever fluctuated. Annually, the lowest levels occur in the fall, the highest in late spring, sometimes continuing into the summer months.

The Oroville Field Division of the DWR monitors water quality in Lake Oroville. Temperature levels near the dam are measured monthly at intervals from the surface to the bottom of the intake structure. Data provided by the OFD (Ed Robbins, DWR, pers. comm.) indicate that turbidity levels were measured at intervals throughout the water column during 1997, but only surface measurements for turbidity are available for other years. These data also indicate that other field parameters, including DO, pH, and conductivity, have only been measured from near the surface of the reservoir near the dam.

Water samples are collected monthly near the dam from the spring to fall periods for nutrient analyses, which include total and dissolved ammonia, nitrate plus nitrite, ortho-phosphate, and total phosphorus. Data obtained from the Division of Operations and Maintenance (DO&M) (Chris Ericson, DO&M, pers. comm.) indicate that mineral data are not collected from the reservoir. Analysis for dissolved iron was conducted from a sample collected in August 1977, and analyses for dissolved aluminum, arsenic, chromium, copper, iron, lead, manganese, and selenium were conducted from a sample collected in April 1989. In addition, during the summer of 1997, the Environmental Assessment Branch of the Division of Operations and Maintenance evaluated the concentrations of methyl-tertiary butyl ether (MTBE) in SWP reservoirs, including Lake Oroville.

4.4.2.1 Field Parameters in Lake Oroville

Water temperatures in Lake Oroville are generally about 45°F from the surface to the bottom from about December though March (Figure 4.4-1). Thermal stratification, in which significant temperature differences develop between the upper and lower portions of the reservoir, begins as early as April and peaks in July and August with surface temperatures of about 75°F. The uppermost layer of warmwater (epilimnion) extends to a depth of about 20 feet during summer stratification. The thermocline, which is the transition layer between the epilimnion and the bottom coldwater layer or hypolimnion,

Click here to access Figure 4.4-1

extends to about 65 feet, below which hypolimnetic water temperatures remain at about 45°F during the summer. Surface water temperatures begin cooling by September, which gradually erodes the epilimnion and thermocline during the fall to achieve uniform water column temperatures by December. Winter stratification, in which near-freezing less dense water forms the surface layer, does not occur due to the large mass of relatively warmwater in Lake Oroville during the winter.

Turbidity levels during the spring of 1997 ranged as high as 13 NTUs near the surface to 25 NTUs at approximately 100 feet in depth (Table 4.4-2). Turbidity levels decreased through the spring and summer; by late fall, turbidity levels ranged from 1.4 NTUs at the surface to 5 NTUs at approximately 100 feet in depth. However, turbidity levels at deeper depths were significantly higher, with a turbidity of 22 NTUs measured at a depth of 167 feet. Surface turbidity levels during 1998 ranged as high as 5 NTUs during the early spring, but decreased to 1.2 NTUs by mid-summer and 0.58 NTUs by late fall. During 1999, surface turbidity levels ranged only to 1.6 NTUs during the early spring, decreased to 1 NTU by mid-summer, but increased slightly to 1.2 NTUs by late fall. A similar pattern was observed for measurements during 2000, with spring turbidity levels of 1.8 NTUs, mid-summer levels of 1 NTU, and fall levels of 1.5 NTUs.

Data indicate that the DO levels from the surface of Lake Oroville near the dam have ranged from 7.8 to 12 mg/L. The highest oxygen levels have generally been found during the early spring, while the lowest levels have been found during the summer. The warm summer water temperatures decrease the carrying capacity of the surface water for oxygen, which, though possessing less oxygen than during the winter months, becomes supersaturated due to photosynthetic activity of algae. The pH of the surface water of the reservoir has hovered around 7.0, with a range of 6.8 to 7.4. Measurements of conductivity indicate a range from 31 to 85 μmhos/cm from the surface of the reservoir near the dam. The oxygen, pH, and conductivity levels for the surface water near the dam comply with Basin Plan objectives.

4.4.2.2 Nutrients in Lake Oroville

Nutrient concentrations found in Lake Oroville have generally been at low levels, typical of those of other lakes and reservoirs that do not experience excessive algal growths. Total phosphorus concentrations have usually been present at low levels but were occasionally found at levels found to be stimulatory to excessive algal growths in other water bodies.

Table 4.4-2: Range of Field and Laboratory Data from Lake Oroville and the Lower Feather River (mg/l except as noted)

	Lake Oroville		Feather River at Oroville		Thermalito Forebay at Power Canal		Thermalito Afterbay at Feather River Outlet	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Miscellaneous								
Dissolved oxygen	7.8	12	9	12.1	9.1	12.1	8.9	13.1
pH	6.8	7.4	6.8	7.5	5.9	8.1	6	8.6
Conductivity (µmhos/cm)	31	85	59	106	62	126	60	130
Alkalinity			28	55	29	48	27	52
Turbidity (NTU)	0.58	25	0.5	99	1	50	1.4	54
Nutrients								
Ammonia & organic nitrogen			0.1	0.8				
Nitrate & nitrite	0.01	0.13	<0.1	0.2	0.02	0.21	0.01	0.35
Ammonia	0.03	0.7	<0.01	0.02	0.01	0.5	0.02	0.5
Ortho-phosphate	0.01	0.12	<0.01	0.05	0.01	0.03	0.01	0.2
Total phosphorus	0.01	0.57	<0.01	0.05	0.01	0.25	0.01	0.38
Minerals								
Calcium			7	12				
Magnesium			3	5	2	6.3	2	5
Sodium			2	8	2	6	2	7
Potassium			0.3	1.3	0.7	1.5	0.7	1.1
Sulfate			1.8	3	0.2	8	0.2	17
Chloride			1	2	0.4	3	0.1	3
Fluoride					0.1	0.4	0.1	0.4
Boron			<0.1	<0.1	0.01	0.3	0.01	0.1
Hardness			30	42	23	56	23	58
ASAR				0.5		0.3		0.4
Total dissolved solids					37	82	29	95
Metals								
Aluminum					<0.01	0.035	<0.01	0.028
Arsenic	<0.001	<0.001	<0.001	0.354	<0.001	0.03	<0.001	0.005
Barium					<0.05	0.05	<0.05	<0.05
Cadmium			<0.001	0.002	<0.001	0.01	<0.001	<0.001
Chromium	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005
Copper	<0.005	<0.005	<0.01	<0.01	<0.001	0.09	<0.001	0.009
Iron	0.01	0.008	0.11	0.68	<0.005	0.14	<0.005	0.08
Lead	<0.005	<0.005	<0.003	<0.003	<0.001	0.05	<0.001	<0.001
Manganese	<0.005	<0.005	0.008	0.5	<0.005	0.039	<0.005	0.02
Mercury			<0.0004	0.00077	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum			<0.01	<0.01				
Selenium	<0.001	<0.001	<0.002	<0.002	<0.001	0.02	<0.001	0.01
Silver					<0.001	<0.001	<0.001	<0.001
Zinc			<0.01	0.04				
Benthic Macroinvertebrates								
Number of individuals/sq. ft				428.3				
Number of species				23				
Diversity index				2.4				
Equitability index				0				

Ammonia has been found in Lake Oroville at concentrations that are well below the criteria for protection of aquatic life.

4.4.2.3 Metals in Lake Oroville

The only metal found from the two samples from Lake Oroville at levels greater than the detection level was iron (Table 4.4-2), but iron concentrations were still well below any criteria for protection of beneficial uses. The other metals analyzed were also below criteria for protection of beneficial uses since the detection levels are less than the various criteria.

4.4.2.4 MTBE Evaluation in Lake Oroville

MTBE has been used in gasoline since 1979 to reduce engine knocking and reduce air pollution. MTBE was required to be added to gasoline in 1979 in cities that exceeded the carbon monoxide air quality standard during the winter, and since 1996 throughout California the entire year. MTBE has been detected in groundwater typically from leaking underground storage tanks and in surface waters largely as a result of unburned fuel from 2-stroke watercraft engines. Governor Gray Davis has ordered the chemical to be phased out of the gasoline supply of California by the end of 2002.

The Division of Operations and Maintenance conducted monthly monitoring for MTBE from May to November of 1997 in Lake Oroville (DWR 1999). Surface samples were collected from the lake at Bidwell Canyon, Lime Saddle, and Loafer Creek boat ramps, and near the surface, above the thermocline, and in the hypolimnion near the dam. MTBE concentrations generally increased from the spring to summer as watercraft use increased, but then rapidly decreased as fall approached and fewer watercraft were used. MTBE was detected in all surface samples from the boat ramps, ranging in concentration from two to 9 µg/L. Six of eight samples collected from the surface of the lake near the dam contained MTBE ranging in concentration to 3 µg/L. Half of the samples collected near the dam above the thermocline contained MTBE with concentrations ranging as high as 5 µg/L. MTBE was not detected in samples collected from the hypolimnion. By the end of the boating season in November, MTBE was no longer detected in any samples collected near the dam.

4.4.3 Water Quality in the Lower Feather River

The Northern District of the DWR generally collected water quality data bimonthly from the Feather River at the USGS Gaging Station, which is about 0.4 mile downstream from the Thermalito Diversion Dam and 300 feet upstream from the Fish Barrier Dam. Data collected from January 1992 to May 1997 include field parameters (conductivity, water temperature, dissolved oxygen, pH, turbidity, and alkalinity); nutrients (total ammonia and organic nitrogen, nitrate plus nitrite, ortho-phosphate, and total phosphorus); minerals (calcium, magnesium, sodium, potassium, sulfate, and chloride); and metals (arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, selenium, and zinc). Only field parameters were measured from June 1997 through July 2000. Beginning in August 2000, quarterly analyses have been performed for field parameters, nutrients, minerals, and low levels of metals.

The USGS recorded temperatures at this station from October 1958 through September 1992 (USGS 1993). The Northern District has recorded water temperatures at this station since September 1995. Benthic macroinvertebrates were collected from the Feather River in September 1995.

Water temperatures have also been recorded by the OFD at the Feather River Fish Hatchery since initiation of hatchery operation, and Robinson Riffle at river mile 61.6 since 1997. Since 1996, DWR has also operated a network of electronic thermisters in the Feather River below Lake Oroville.

4.4.3.1 Field Parameters in the Lower Feather River

Most field parameters measured in the Feather River at the gage have been within the established goals and criteria. Dissolved oxygen levels in the Feather River at the monitoring site have ranged from 9.0 to 12.1 mg/L, while pH has ranged from 6.8 to 7.5 and conductivity has ranged from 59 to 106 μmhos/cm. These values are well within the goals of the Basin Plan for protection of beneficial uses.

Impoundment of the Feather River by Oroville Dam has resulted in a decrease of the maximum and increase in the minimum annual water temperatures measured at the USGS gage (Figure 4.4-2). Prior to impoundment, data from the USGS indicate that maximum water temperatures in the Feather River typically ranged from 70 to 75°F, and

Click here to access Figure 4.4-2

rarely reached temperatures just over 80°F. Minimum water temperatures prior to impoundment typically ranged to around 35°F. Subsequent to impoundment of the Feather River, the reservoir releases have been operated to comply with temperature requirements at the Feather River Fish Hatchery, but operations have not been modified. Maximum water temperatures have been rather uniform around 63°F. Low water storage during a drought resulted in a maximum water temperature of 68°F in 1977. Minimum water temperatures in the Feather River subsequent to impoundment have generally ranged from about 43 to 45°F.

Mean summer water temperatures measured since late 1995 at the USGS gage have generally been less than the 65°F for steelhead management. Mean water temperatures after the first of September have been within the 53°F to 57.5°F temperatures recommended for spring-run spawning and rearing during the summer rearing period (Figure 4.4-3) (DWR & USBR 2000).

Water temperatures downstream at Robinson Riffle were as much as 5ºF warmer than those at the USGS gage during summer 2000 (Figure 4.4-4). Water temperatures ranged as high as 66.1°F in early August, and did not cool to less than 60°F until the first of September. Water temperatures uniformly less than 56°F were not achieved until late September.

Water temperatures at the Feather River Fish Hatchery are recorded as daily mean values. The agreement with the DFG, however, stipulates daily maximum temperature requirements. Daily mean water temperatures measured at the USGS gage are very similar to those measured at the hatchery, so daily maximum water temperatures are also likely very similar. In addition, water temperatures at the hatchery would be at least as high as those measured at the gage during the warmer portions of the year, so that any temperatures at the gage that exceed those stipulated in the agreement would also be greater than agreement temperatures at the hatchery. Maximum water temperatures measured at the gage since the fall of 1995 have typically been within the range of those allowed by the agreement (Figure 4.4-5). Only on rare occasions have maximum water temperatures slightly exceeded those allowed, but then for only brief periods of a day or so.

Turbidity at the Feather River monitoring site was generally at low levels and reflects the turbidity of the upper tributaries feeding Lake Oroville. Most measured values were well

Click here to access Figure 4.4-3

Click here to access Figure 4.4-4

Click here to access Figure 4.4-5

below 10 NTUs. However, highly turbid inflows during some winter periods resulted in significantly increased turbidity levels in the Feather River at the monitoring site. During the winter of 1996, when turbidity levels of 60 NTUs were measured in upstream tributaries, a turbidity of 14.0 NTUs was measured at the monitoring site. Similarly during the winter of 1997 when tributary turbidity was high, measurements in the Feather River produced a turbidity of 99 NTUs, the highest level found at this site.

4.4.3.2 Nutrients in the Lower Feather River

Nutrient levels in the Feather River downstream from Oroville Dam have been less than those found in the reservoir. Total phosphorus concentrations have been much less than those considered stimulatory to excess algal production.

The concentrations of ammonia detected in the Feather River downstream from Oroville are well below the criteria for protection of aquatic life.

4.4.3.3 Minerals in the Lower Feather River

Mineral levels in the Feather River downstream from Oroville Dam are lower than those found in the tributaries to the reservoir. Boron has not been detected from any of the samples. The low mineral concentrations indicate that the water from the river is suitable for all beneficial uses.

4.4.3.4 Metals in the Lower Feather River

Most metals for which analyses have been conducted for the Feather River downstream from Oroville Dam meet the criteria for protection of beneficial uses. However, several metals have been found to exceed various criteria. While previous analyses did not detect arsenic at levels that exceeded any criteria, a recent analysis using low level detection methods for total arsenic found concentrations exceeding the EPA NTR criterion for continuous concentration, agricultural goal, and drinking water primary standard. Total recoverable cadmium and copper have been found to occasionally exceed the NTR criterion for continuous concentration. The recent low level detection method has also identified total recoverable mercury concentrations that greatly exceed the NTR criterion for continuous concentration, EPA National Ambient Water Quality Criterion for continuous concentration, and the EPA CTR criterion for protection of drinking water and aquatic organisms for consumption.

4.4.3.5 Biological Monitoring in the Lower Feather River

Benthic macroinvertebrate samples from a riffle habitat collected near the gaging station on September 19, 1995 contained 428 organisms per square foot of substrate, and contained 23 different taxa. The community was dominated by *Orthocladinae* dipterans, which comprised nearly 40 percent of the total number of individuals. Other dominant species included the dipteran *Simulium*, mayfly *Baetis*, and caddisfly *Hydropsyche*, whose members comprised 13, 14, and 23 percent of the community, respectively. These four groups comprised 90 percent of the total number of organisms. Diversity was calculated as 2.4, while equitability was determined to be 0, which indicate poor conditions.

Members of the *Orthocladinae*, *Simulium*, *Baetis*, and to a lesser extent *Hydropsyche* are tolerant of a wide variety of conditions. These species rapidly colonize disturbed habitats and have short generation times. Nearly all other organisms present were represented by very few individuals. No predatory macroinvertebrates were present, which would allow the few species colonizing this site to develop large numbers of individuals.

Dams typically alter the physical conditions of downstream habitats. Water temperatures are cooler than normal during the summer, and warmer than normal during the winter. These altered temperature patterns prevent colonization by many aquatic macroinvertebrates, especially the longer lived predatory species, which possess both an aquatic and terrestrial life cycle. Such organisms may develop more rapidly than normal during the winter when water temperatures are warmer, but less rapidly during the summer due to cooler than normal water temperatures. These altered development patterns result in the organism emerging from the aquatic to the terrestrial habitat at a time of year when conditions are not suitable for their survival. The food regime downstream from a dam is also altered due to release of water containing large amounts of algae and other organic materials, favoring species that sift the water for detritus. In addition, substrate alterations typically occur downstream from dams, whereby gravels are flushed downstream by occasional high flows but are not replaced due to blockage of migrating gravels by the dam, which leaves only larger cobbles or bedrock for colonization. These and other habitat modifications at the site where the benthic macroinvertebrates were collected are probably responsible for the type of communities found. Farther downstream, the community would be expected to be more typical of natural communities as the river becomes more influenced by natural processes.

4.4.4 Thermalito Forebay and Afterbay Water Quality

The OFD collects samples at quarterly from the Thermalito Forebay Power Canal for minerals (calcium, magnesium, sodium, sulfate, chloride, fluoride, and boron); metals (aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, silver, and zinc); conductivity; turbidity; pH; dissolved solids; and alkalinity. Data are also available for nutrient analyses (total and dissolved ammonia, nitrate plus nitrite, ortho-phosphate, and total phosphorus) from samples collected until the end of 1993. Available data indicate that monthly samples are collected from the Thermalito Afterbay river outlet for nutrients (nitrate plus nitrite, ammonia, ortho-phosphate, and total phosphorus); minerals (calcium, magnesium, sodium, sulfate, chloride, fluoride, bromide, and boron); metals (aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, and silver); conductivity; turbidity; pH; dissolved solids; and alkalinity. In addition, quarterly samples are collected for suspended solids analyses. Analyses for MTBE in the Thermalito Afterbay was conducted from May to November 1997.

The USGS published records of maximum and minimum daily water temperatures measured by the OFD at the Thermalito Afterbay river outlet from October 1968 through September of 1992 (USGS 1993). Since 1992, these temperature data have not been published, and only mean daily water temperature data are available (Ed Robbins, DWR, pers. comm.). The OFD has also measured water temperatures in the Thermalito Afterbay at the Western Canal diversion since April 10, 2000.

4.4.4.1 Field Parameters in the Thermalito Forebay and Afterbay

Mean daily water temperatures at the Thermalito Afterbay river outlet from October 1968 through September 1992 are approximated by averaging the daily maximum and minimum water temperatures for comparison to more recent daily mean temperature data (Figure 4.4-6). Daily mean water temperatures measured during the summer prior to 1995 have generally been in the low to upper 70°F range. Since 1995, however, mean daily water temperatures during the summer have been in the upper 60°F range, and rarely have ranged as high as 70°F. The lower temperatures in more recent years are due to changes in operation of the SWP (Ed Robbins, OFD, pers. comm.). Prior to 1992, reservoirs in Southern California were filled during the winter and early spring. Since then, however, additional water has been released during the summer from Lake Oroville to fill the Southern California reservoirs due to restrictions on pumping from the Delta during the late spring and early summer to protect the delta smelt and outmigrating

Click here to access Figure 4.4-6

juvenile salmon. Most of the additional releases of coldwater from Lake Oroville are routed through the Thermalito Afterbay, which has resulted in cooler temperatures in this body of water.

Local irrigation districts have considered water temperatures of about 65°F from April through mid-May needed for rice germination and of about 59°F during the remainder of the season for growth. Mean daily water temperatures measured at the Western Canal during the year 2000 were significantly cooler than those desired for rice germination, but were suitable for subsequent growth (Figure 4.4-7). Mean daily water temperatures measured since mid-April 2000 at the afterbay outlet to the Western Canal were very similar to those measured at the Afterbay Outlet to the Feather River during the early spring and summer but were generally a few degrees cooler during the late spring. Since water temperatures at the afterbay outlet to the Feather River are similar to those at the Afterbay Outlet to the Western Canal, mean daily water temperatures at the Thermalito Afterbay Outlet can be used to evaluate water temperature suitability for rice production in earlier years.

Since 1995, mean daily water temperatures at the Thermalito Afterbay Outlet to the Feather River have been less than those considered suitable for rice germination and have often been less than those considered suitable for a portion of the rice growing season (Figure 4.4.8). Mean daily water temperatures for the 10-year period from 1983 to 1992 have also often been less than those considered to be suitable for rice germination but have generally been suitable during the growing season. Comparison of average mean daily water temperatures for these two periods indicates that early spring water temperatures were several degrees warmer prior to re-operation of water deliveries to better protect the delta smelt and juvenile salmon than those since re-operation of the project, although still generally cooler than those desirable for rice germination. Average mean daily water temperatures were also significantly warmer during the growing season generally suitable.

Field parameters are very similar in samples collected from the Thermalito Power Canal and Thermalito Afterbay at the Feather River Outlet. Measured conductivity has ranged as high as 126 μmhos/cm from the Thermalito Power Canal and 130 μmhos/cm from the Thermalito Afterbay at the Feather River Outlet, meeting requirements of the Basin Plan. Turbidity levels have ranged as high as 50 NTUs at the Power Canal and 54 NTUs at the Afterbay Outlet, while total dissolved solids at these two sites has ranged to 82 and 95 for

Click here to access Figure 4.4-7

Click here to access Figure 4.4-8

rice prior to re-operation of the project, although temperatures during both periods are mg/L, respectively. Turbidity levels at these sites are affected by turbidity levels in the reservoir. Total dissolved solid (TDS) levels found at these sites are well below the drinking water limit of 500 mg/L. Laboratory pH has ranged from 5.9 to 8.1 at the Power Canal and 6.0 to 8.6 at the Afterbay Outlet. The Basin Plan requires that pH levels not be depressed below 6.5, but does not address natural pH levels that are less than this threshold. In addition, laboratory pH measurements do not reflect actual field conditions due to biochemical reactions that alter pH levels within a very short time period following sample collection. Total alkalinity has ranged from 29 to 48 mg/L as $CaCO_3$ at the Power Canal and 27 to 52 mg/L as $CaCO_3$ at the Afterbay Outlet. The EPA recommends a minimum alkalinity of 20 mg/L for protection of aquatic life.

4.4.4.2 Nutrients in the Thermalito Forebay and Afterbay

Nutrients at both the Thermalito Power Canal and Afterbay Outlet have been found at about the same range of levels as found in Lake Oroville, except for an unusually high total ammonia level reported from August 1983 from the Afterbay Outlet. While total ammonia from the Afterbay Outlet typically ranges as high as 0.5 mg/L, a concentration of 4.7 mg/L was reported from a sample collected in August 1983. Total phosphorus concentrations detected from the Power Canal and Afterbay Outlet have been slightly lower than those reported from Lake Oroville, although still considered stimulatory for algal production according to draft guidelines developed by the EPA (EPA 1999).

4.4.4.3 Minerals in the Thermalito Forebay and Afterbay

Concentrations of minerals in samples from the Thermalito Power Canal and Afterbay Outlet have been very similar to those found from the Feather River at the USGS Gaging Station. The highest boron level detected was 0.3 mg/L from the Thermalito Power Canal and 0.1 mg/L from the Afterbay Outlet, which indicates suitability as irrigation water. Calculated adjusted sodium adsorption ratios (using calcium data from the Feather River at the USGS gage for part of the calculation since calcium was not reported from the Power Canal or Afterbay) are also low, with values of only 0.3 and 0.4 from the Thermalito Power Canal and Afterbay Outlet, respectively, which also indicates suitability for agricultural uses.

4.4.4.4 Metals in the Thermalito Forebay and Afterbay

Several metals have been reported from samples collected from the Thermalito Power Canal and Afterbay Outlet, including aluminum, arsenic, copper, iron, manganese, and selenium. In addition, barium, cadmium, and lead have also been reported from samples from the Afterbay Outlet. Many of the analyses from which metals had been reported, including those for arsenic, cadmium, copper, iron, lead, and manganese from the Afterbay Outlet and selenium from both the Power Canal and Afterbay Outlet, were from samples collected prior to the early 1980s. Subsequent analyses using analytical methods with better detection limits have not detected the presence of cadmium or selenium at either monitoring site, while arsenic, copper, iron, lead, and manganese levels at the Afterbay Outlet have been reported at much lower concentrations.

Copper has been occasionally detected from the more recent analyses at both the Thermalito Power Canal and Afterbay Outlet at concentrations that exceed the criteria for protection of aquatic life of the CTR. Lead concentrations from the more recent chemical analyses have occasionally been reported from the Power Canal at concentrations that exceed the CTR and NTR criteria for protection of aquatic life. The detection level used for mercury analyses is not sufficient to determine whether criteria for protection of aquatic life were exceeded.

4.4.4.5 Biological Monitoring in the Thermalito Forebay and Afterbay

Potential coliform bacteria contamination in the North Forebay Recreation Area has been a concern to recreationists and the Department of Parks and Recreation (DPR) (Hal Bradshaw, DPR, pers. comm.). However, no analyses have been conducted for coliform bacteria from this area (Doug Fogle, Butte County Environmental Health Department, pers. comm.). Poor circulation of water within the recreation area and several possible sources of coliform contamination, including sanitation habits of people and the large number of waterfowl that use the site, could lead to the presence of coliform bacteria.

The Basin Plan establishes objectives for coliform bacteria in waters designated for contact recreation, which includes the Thermalito Forebay and Afterbay. The plan states that fecal coliform must not exceed a mean of 200 organisms per 100 mL of water from a minimum of five samples collected during a 30-day period, nor shall more than 10 percent of the samples taken during a 30-day period exceed 400 organisms per 100 mL.

4.4.4.6 MTBE in the Thermalito Forebay and Afterbay

Monthly monitoring for MTBE in the Thermalito Afterbay was conducted from May to November 1997 by the Division of Operations and Maintenance. Concentrations of the gasoline additive increased as the recreation season progressed, reaching a peak concentration of 11 μg/L following the Labor Day weekend. Subsequent monitoring continued to detect MTBE at lower concentrations through the end of the study.

4.5 AQUATIC RESOURCES

4.5.1 General Description

The reservoirs associated with the Oroville Facilities support both coldwater and warmwater fisheries. The Lake Oroville bass fishery is regionally important. Downstream of the Oroville Facilities, the lower Feather River supports anadromous and resident fish species. Historically, the chinook and steelhead migrated upstream of the Oroville Facilities. The Fish Hatchery Facilities were constructed as mitigation for the loss of upstream habitat.

4.5.2 Reservoirs

4.5.2.1 Lake Oroville

Lake Oroville Overview

Lake Oroville contains a "2 story" fishery, which means that it supports both coldwater and warmwater components that are thermally segregated for most of the year. The coldwater fish use the deeper, cooler, well-oxygenated hypolimnion, whereas the warmwater fish are found in the warmer, shallower, epilimnetic, and littoral zones. Once Lake Oroville destratifies in the fall, the two fishery components mix in their habitat utilization. Lake Oroville's coldwater and warmwater fish are listed in Table 4.5-1 with the lake's record fish in Table 4.5-2.

On February 15, 2000, DWR submitted its 1999 Lake Oroville Annual Report of Fish Stocking and Fish Habitat Improvements (DWR 2000b) to FERC. This document contains proposed stocking levels for Lake Oroville, as well as proposals for other fishery management activities at the reservoir. This document is currently under FERC review and may be revised.

Table 4.5-1: Lake Oroville Fish Species

Gamefish	
Chinook Salmon	*Oncorhynchus tshawytscha*
Brown Trout	*Salmo trutta*
Rainbow Trout	*Oncorhynchus mykiss*
Lake Trout	*Salvelinus namaycush*
Spotted Bass	*Micropterus punctulatus*
Largemouth Bass	*Micropterus salmoides*
Smallmouth Bass	*Micropterus dolomieui*
Redeye Bass	*Micropterus coosae*
Bluegill	*Lepomis macrochirus*
Green Sunfish	*Lepomis cyanellus*
Redear Sunfish	*Lepomis microlophus*
Black Crappie	*Pomoxis nigromaculatus*
White Crappie	*Pomoxis annularis*
Channel Catfish	*Ictalurus punctatus*
White Catfish	*Ictalurus catus*
Non-Gamefish	
Sacramento Pike Minnow	*Ptychocheilus grandis*
Hardhead	*Mylopharodon conocephalus*
Carp	*Cyprinus carpio*
Goldfish	*Carassius auratus*
Threespine Stickleback	*Gasterosteus aculeatus*
Sculpin*	*Cottus* sp.
Sacramento Sucker	*Catostomus occidentalis*
White Sturgeon **	*Acipenser transmontanus*
Warmouth**	*Lepomis gulosus*
Primary Forage Fish	
Wakasagi	*Hypomesis nipponensis*
Threadfin Shad	*Dorosoma petenense*

Several species of "minnows" are often introduced to Lake Oroville by anglers, the primary species being the golden shiner, *Notemigonus crysoleucus.*

* The few Sculpins that have been sampled over the last six years were not identified to species.

** These fish have not been observed in any sampling conducted since 1993, but have been reported and/or observed before.

Table 4.5-2: Lake Oroville Record Fish

Species	Weight	Year
Chinook Salmon	19 lbs. 11 oz.	1987
Coho Salmon	9 lbs.	1989
Rainbow Trout	16 lbs.	1990
Brown Trout	15 lbs.	1979
Lake Trout	11 lbs.	1992
Largemouth Bass	14.15 lbs.	1998
Smallmouth Bass	6 lbs. 2 oz.	1992
Spotted Bass	7 lbs.	1993
Redeye Bass	3 lbs. 4 oz.	1983
Black Crappie	2 lbs. 10 oz.	1983
White Crappie	3 lbs. 4 oz.	1993
Channel Catfish	25 lbs.	1992
White Catfish	27 lbs. 4 oz.	1992
Sacramento Squawfish	10 lbs. 2oz.	1992
Carp	14 lbs. 5 oz.	1983
White Sturgeon	97 lbs.	1989

Lake Oroville Coldwater Fishery

Lake Oroville's coldwater fishery is primarily comprised of chinook salmon and brown trout, although rainbow trout and lake trout are periodically caught. The fishery is managed by the DFG with two primary objectives: the first is to produce trophy (> 5 lbs.) salmonids, the other is to provide a quality fishery characterized by high salmonid catch rates. These management strategies are explained by DFG in detail in DWR's 1999 Lake Oroville Annual Report of Fish Stocking and Fish Habitat Improvements (DWR 2000b). The coldwater fishery is sustained by hatchery stocking because natural recruitment to the Lake Oroville coldwater fishery is very low. This is due to insufficient spawning and rearing habitat in the reservoir and accessible tributaries, and natural and artificial barriers to migration into the tributaries with sufficient spawning and rearing habitat. A "put-and-grow" hatchery program is currently in use, where salmonids are raised at DFG hatcheries and stocked in the reservoir as juveniles (>5 per pound), with the intent that these fish will grow in the reservoir before being caught by anglers. This contrasts with a "put-and-take" program, where salmonids are grown to a "catchable" size (~2 per pound) before being stocked, with the intent of providing a more immediate return to the angler. Lake Oroville stocking numbers are presented in Table 4.5-3.

Chinook salmon are the primary coldwater fish now stocked in Lake Oroville. They are part of the DFG Inland Chinook Program, where chinook salmon eggs are taken from surplus fall-run salmon at the Feather River Fish Hatchery. These eggs are hatched out and raised under quarantine conditions until such time as DFG pathologists can test them for certification as free of harmful diseases. The fish are then either stocked in Lake Oroville as fingerlings (~60 per pound or ~3 inches long) in the spring, or they are held in the Feather River Fish Hatchery and grown to yearling size (~8 per pound or ~6 inches long) and stocked in the fall. Several hundred thousand inland chinook are stocked in other California reservoirs on an annual basis as well.

Brown trout are the only other salmonid currently stocked in Lake Oroville. They are planted as subcatchables (~15 per pound) in the fall, from DFG's Crystal Lake Hatchery.
Rainbow trout are no longer stocked in California reservoirs with wakasagi as a primary forage fish because, for the most part, these programs have not been successful. In addition, *Ceratomyxa shasta*, a myxozoan parasite that is lethal to most strains of rainbow trout, is prevalent in Lake Oroville. After poor success with rainbow trout stocking in the 1970s and 80s, the DFG abandoned rainbow trout as a management option at Lake Oroville. Rainbows are still caught in Lake Oroville in low numbers; these are probably fish that migrate down from the tributaries.Lake trout were stocked in Lake Oroville in the mid 1980s, but the program was abandoned due to lack of a reliable egg source, and their numbers in the catch have dwindled. A few are still caught each year, which could indicate that a few lake trout may spawn on deep shoals in the reservoir; however, a more likely explanation is that they migrate down from lakes in the upper Feather River watershed where they are stocked every year.

Recent, very serious disease concerns at Lake Oroville and the Feather River Fish Hatchery have called the reservoir’s current salmonid stocking strategy into question. DWR is working with DFG to develop a new stocking plan that will address disease issues as well as continue to provide an attractive coldwater fishery. This plan will be filed with FERC as a revision to the stocking recommendations that were made in the 1999 Lake Oroville Annual Report of Fish Stocking and Fish Habitat Improvements (DWR 2000b)

TABLE 4.5-3 *TOTAL LAKE OROVILLE SALMONID STOCKING - ALL YEARS

	RT - FING	RT - SUB	RT - CAT	BN - FING	BN - SUB	BN - CAT	KS - FING	KS - YEAR	SS - FING	SS - YEAR	KOK - FING	EB-C or LT-F	ANNUAL TOTAL	
1968	779522	322400		2560	90475						60000		1254957	1968
1969	140884	43720	400	643200		200				42700			871104	1969
1970		18800	12400		65200	36400				60900	164200		357900	1970
1971			24209			20500				16461			61170	1971
1972	60250	4601	34259			31230				89598			209782	1972
1973		54150	3600			31205				67320	275200		431475	1973
1974			40705			15000				37500			93205	1974
1975			54990		16400	5400				65460	300495	2000	444745	1975
1976			40101			18400		48280		67510	230000		404291	1976
1977			40000		24800	10001				60013	181440		316254	1977
1978		60000	80000			27000							167000	1978
1979			113314		25010	20420		22400					181144	1979
1980	110000		168180			20650							298830	1980
1981			34400			51000							85400	1981
1982			40484			37400		100225					178109	1982
1983			10000			15000		165870					190870	1983
1984						35100		125410				54255	214765	1984
1985				10000	20000	16200	166250	31360				31200	269010	1985
1986			7400			65920		43250					116570	1986
1987						68630			63550	43655			175835	1987
1988			221			44200	31360	23680	38500				137961	1988
1989						28700	62305						91005	1989
1990						57400							57400	1990
1991						33838	143100	60750					237688	1991
1992					68556		87000	35980					191536	1992
1993					123855	7800	102585	60650					294890	1993
1994					50004		104410	55200					209614	1994
1995					65400		101922	90001					257323	1995
1996				8402	80200		105841	150435					344878	1996
1997					67403		105000	250000					422403	1997
1998					55000		106163	352970					514133	1998
1999					50008		128750	158290					337048	1999
2000					155700			28600					184300	2000
TOTALS	1080656	503571	704609	664162	958211	691594	1244686	1803151	102050	551075	1211335	87455	9602605	TOTAL
	RT - FING	RT - SUB	RT - CAT	BN - FING	BN - SUB	BN - CAT	KS - FING	KS - YEAR	SS - FING	SS - YEAR	KOK - FING	EB or LT		

9724905 SUM TOTAL WITH LOFEC STOCKING INCLUDED

LEGEND

BN -	BROWN TROUT	FING -	FINGERLING	LOFEC STOCKING:	1984	22600 BN
EB-C or LT-F -	EB-C = EASTERN BROOK - CAT (1975)	YEAR -	YEARLING		1985	100000 SS
	LT-F = LAKE TROUT - FING ('84 & '85)	SUB -	SUBCATCHABLE		1986	130000 SS
KOK -	KOKANEE SALMON	CAT -	CATCHABLE		1991	54000 SS - FING
KS -	KING (CHINOOK) SALMON					
RT -	RAINBOW TROUT					
SS -	SILVER (COHO) SALMON					

PRE-DWR ANNUAL STOCKING AVERAGE (1968 - 1992) 250793
DWR ANNUAL STOCKING AVERAGE (1993 - 1999) 340813

*DATA SOURCES:

1968 - 1992 TOTALS -	DEPARTMENT OF FISH AND GAME FILES
1993 - 1999 TOTALS -	DEPARTMENT OF WATER RESOURCES FILES
LOFEC STOCKING -	LAKE OROVILLE FISH ENHANCEMENT COMMITTEE

Lake Oroville Warmwater Fishery

The Lake Oroville fishery is a regionally important self-reproduction fishery, comprised of four species of black bass, two species of catfish, two species of sunfish, and two species of crappie. A small experimental plant of Florida strain largemouth bass also occurred during the fall of 2000. The black bass fishery is the most significant, both in terms of angler effort and economic impact on the area. Spotted bass are the most abundant bass species in Lake Oroville, with largemouth being next, followed by redeye and smallmouth bass. The DFG manages the bass fishery with special angling regulations that require the release of all bass between 12 and 15 inches. Lake Oroville's catch rates of quality (>12 inches) bass are among the highest of any large two story reservoir in California, (Table 4.5-4) making Oroville one of the most popular bass fisheries in the state. Lake Oroville attracts not only sport anglers, but a large number of bass tournament anglers as well.

Table 4.5-4: Lake Oroville Bass Fishery Comparison*

Water	Most Abundant Black Bass Species	Mean Black Bass Catch Per Hour	Mean Black Bass Weight (lbs)
Lake Oroville	Spotted Bass	0.250	2.20
Lake Shasta	Spotted Bass	0.265	1.43
Trinity Lake (Clair Engle)	Smallmouth Bass	0.252	1.41
Lake McClure	Spotted Bass	0.221	1.29
Folsom	Spotted Bass	0.187	1.50
Lake Don Pedro	Largemouth Bass	0.186	1.55
New Melones Lake	Largemouth Bass	0.158	1.68
Millerton Lake	Spotted Bass	0.155	1.23
Isabella Lake	Largemouth Bass	0.088	2.18
*Data from DFG: "Assessment of California Black Bass Angling Regulations" November 1994.			

Bass tournaments are scheduled on almost every weekend of the year (Table 4.5-5). The local business community views tournament angling as one of the most significant economic aspects of Lake Oroville recreation because of its potential to bring in millions of dollars to the local area each year (Bryan 1987). The 6-year Lake Oroville Fisheries Habitat Improvement Plan (DWR 1995) was completed during the spring of 2000; it targeted the warmwater fishery and juvenile black bass in particular. This is because the lake's water level fluctuations, steep slopes, and poor soils hinder the establishment of rooted aquatic vegetation in the littoral zone of the reservoir, restricting the encroachment

Table 4.5-5: Lake Oroville "Event Type" Bass Tournaments 2000*

Month	Date	Sponsor	Weigh-In Location
January	29	Won Bass	Bidwell Canyon
	30	Anglers Choice	Spillway
	16	New Bass	Spillway
February	2	Won Bass	Bidwell Canyon
	6	100% Bass	Bidwell Canyon
	12	Gold Country Bassers	
	12	West Coast Bass Inc.	Spillway
	13	West Coast Bass Inc.	Spillway
	20	Anglers Choice	
	27	California Bass Federation	Spillway
March	11	Gold Country Bassers	Spillway
	12	California Bass Federation	Spillway
	18	Chico Bass	
	19	Anglers Choice	Spillway
April	1	Won Bass	Bidwell Canyon
	2	New Bass	Spillway
	15	Bass Busters	Spillway
	16	American Bass	Spillway
	21	Chico Bass & Conservation	Spillway
	29	West Coast Bass Inc.	Bidwell Canyon
	30	California Bass Federation	Spillway
May	6	West Coast Bass Inc.	Bidwell Canyon
	7	New Bass	Spillway
	20	New Bass	Spillway
	21	Anglers Choice	Lime Saddle Marina
June	11	West Coast Bass Inc.	Bidwell Canyon
	17	New Bass	Spillway
	24	Won Bass	Bidwell Canyon

September	10	West Coast Bass Inc.	Bidwell Canyon
	15	Chico Bass & Conservation	Spillway
	16	Bass Busters	Spillway
	17	American Bass	Spillway
	23	Chico Bass	Spillway
October	8	100% Bass	Bidwell Canyon
	14	Won Bass	Bidwell Canyon
	28	California Bass Federation	Spillway
	29	California Bass Federation	Spillway
November	4	John Sweeten	Bidwell
	4	Chico Bass & Conservation	Spillway
	5	Gold Country Bassers	
	11	West Coast Bass Inc.	Spillway
	12	West Coast Bass Inc.	Spillway
		Folsom Bass Team	
December	3	American Bass	Spillway
*Data Provided by the California Department of Parks and Recreation			

of terrestrial vegetation into the fluctuation zone. This lack of cover, which provides spawning and nursery habitat for warmwater fishes, is related to reduced standing crops of centrarchid species as a result of reduced food availability and higher predation on young-of-year fishes (Brouha and Von Geldern 1979). DWR has proposed to continue these projects through 2004, and FERC is considering this proposal.

Catfish are the next most popular warmwater fish at Lake Oroville, with both channel and white catfish present in the lake. They are popular fish to catch in the spring and summer, oftentimes by houseboaters and others who fish at night. They are the largest fish commonly caught in the lake (Table 4.5-2). White and black crappie are both found in Lake Oroville, with the black crappie being more common. Their populations fluctuate widely from year to year. However, a few expert crappie anglers seem to be consistently successful every year. Bluegill and green sunfish are the two primary sunfish species in Lake Oroville, though redear sunfish and warmouth are also present in very low numbers. The high abundance of bluegill and green sunfish has led to stunting in the reservoir. Although common carp are considered by many to be a nuisance species, they are very abundant in Lake Oroville.

The primary forage fish in Lake Oroville are wakasagi and threadfin shad. Threadfin shad were intentionally introduced in 1967 to provide forage for gamefish, whereas the wakasagi migrated down from an upstream reservoir in the mid-1970s.

4.5.2.2 Thermalito Diversion Pool

The Thermalito Diversion Pool is a steep sided, narrow, riverine reservoir with minimal fluctuation in surface elevation and a low surface-to-volume ratio. Since it is supplied by water from Lake Oroville's hypolimnion, it remains cold year round with temperatures seldom exceeding the high 50s. Its has two outlets at its downstream end, one delivers water to the Thermalito Forebay, the other passes water through the Thermalito Diversion Dam Powerplant and into the Fish Barrier Pool, and eventually to the Feather River Low Flow Channel. The Diversion Pool fishery is dominated by coldwater fish, including rainbow trout, brook trout, brown trout, and chinook salmon. Although no fish are currently being stocked in the Diversion Pool, no barriers exist between the Diversion Pool and the Thermalito Forebay, so salmonids stocked in the Forebay freely move into the Diversion Pool. Several trophy salmonids are caught in the Diversion Pool each year, their large size related to the relatively abundant food supply of forage fish entrained in diversions from Lake Oroville through the Edward Hyatt Powerplant. Other than angler survey information, limited fish sampling has been conducted in the Diversion Pool. Warmwater fish such as largemouth bass, bluegill, and green sunfish have been observed in low numbers in backwater areas, and other warmwater fish that live in Lake Oroville are believed to be present as well.

4.5.2.3 Thermalito Forebay

The Thermalito Forebay is a cold, shallow, open reservoir with minor fluctuations in surface elevations and a high surface-to-volume ratio. It remains cold throughout the year because it is supplied with water from the Diversion Pool, although pump-back operations from the Thermalito Afterbay warm the Forebay somewhat. The DFG manages the Forebay as a put-and-take trout fishery, where catchable (about 1/2 lb.) trout are stocked biweekly. Rainbow and brook trout are the primary fish planted, although surplus inland chinook yearlings were stocked in the Forebay in February 2000. The

Forebay coldwater fishery is the second most popular reservoir fishery at the Oroville Facilities.

Other than angler survey information, limited fish sampling has been conducted in the Forebay. Warmwater fish species found in Lake Oroville are believed to exist in the Forebay in low numbers.

4.5.2.4 Thermalito Afterbay

The Thermalito Afterbay is a large, shallow, open reservoir with frequent water level fluctuations and a high surface-to-volume ratio. The Afterbay presents the most complex hydrologic regime of all the Oroville Facilities' reservoirs. It has multiple outlets that deliver water to several different agricultural canals, an outlet that regulates the amount of water that is discharged through the Thermalito outlet into the Feather River, and it also is used in pump-back operations. The shallow nature of the Afterbay results in very noticeable fluctuation effects with only a few feet of surface level changes. Mudflats can be exposed and a significant amount of the littoral zone can be dewatered. Water temperatures can vary widely around the Afterbay in the summer, with water in the low 60s near the tailrace channel that feeds the Afterbay, and water in the mid 80s in the backwater areas that do not readily circulate.

The diverse temperature structure of the Afterbay has provided suitable habitat for both coldwater and warmwater fish. A popular largemouth bass fishery currently exists, and large trout are sometimes caught near the inlet. No salmonid stocking currently occurs at the Afterbay, so these fish most likely passed through the Thermalito Pumping-Generating Plant from the Forebay. Though limited fish sampling has been conducted at the Afterbay, smallmouth bass, rainbow trout, brown trout, redear sunfish, bluegill, black crappie, channel catfish, and carp have all been observed. Most of the Lake Oroville sportfish probably occur in the Afterbay to some degree.

4.5.2.5 Fish Barrier Pool

The Fish Barrier Pool is the small reservoir located between the Thermalito Diversion Dam and the Fish Barrier Dam. No stocking or sampling has been conducted in this reservoir, but the sportfish found in the Diversion Pool also probably occur in the Fish Barrier Pool to some degree.

4.5.3 Feather River Fish Hatchery

Along with the Nimbus Hatchery on the American River and the Coleman National Fish Hatchery on Battle Creek, the Feather River Fish Hatchery ranks among the best chinook salmon hatcheries on the west coast of North America. The hatcheries have more than offset the total salmon losses caused by construction of Folsom, Shasta, and Oroville dams, respectively, and all make substantial contributions to commercial and recreational fisheries.

4.5.3.1 Hatchery Overview

The Feather River Fish Hatchery began operation in 1967 with the original purpose of mitigating for the loss of spawning habitat in the Feather River and its tributaries due to construction of Oroville Dam. With the hatchery, DWR was not required to install fish passage facilities for upstream and downstream migrating anadromous salmonids.

The hatchery mitigates for spawning habitat loss for two races of chinook salmon – the spring and fall runs – and steelhead rainbow trout. This mitigation is particularly important now in that the spring-run and steelhead are listed as threatened under provisions of the federal Endangered Species Act. The fall run is a candidate species.

The DFG operates the hatchery under contract to DWR, and DWR pays all hatchery-associated expenses, except for some costs as part of the enhancement Thermalito facilities.

Over the years, the Feather River Fish Hatchery has assumed three additional important functions. First, the hatchery is a critical source of juvenile chinook salmon used in various studies, leading to a better understanding of salmon life history and management. Second, in the 1990s the hatchery began providing fingerling and juvenile chinook salmon for planting in Lake Oroville. The DFG also plants surplus juveniles from the hatchery in other Northern California reservoirs. Finally, the Feather River Fish Hatchery provides juvenile chinook salmon for enhancement (beyond mitigation) projects at the Thermalito grow out facilities and at the Mokelumne River Fish Facility.

The description of the Feather River Fish Hatchery presented below is broken down into the following sections: production goals, facilities, operations, and evaluation of its success. Significant difference in handling steelhead and chinook salmon adults and juveniles are noted.

4.5.3.2 Production Goals

The annual mitigation goals are to plant:

- 8 million 30/lb. fall-run chinook salmon;
- 2 million 30/lb. spring-run chinook salmon; and
- 0.4 million 3-4/lb. yearling steelhead.

In addition, enhancement goals are to produce 2.6 million 30/lb. fall-run chinook salmon at the Thermalito facilities and to provide sufficient fertilized eggs to produce three million 30/lb. fall-run chinook salmon at the Mokelumne River Fish Facility. Enhancement production is funded primarily from California Salmon Stamp money and salmon landing tax receipts.

4.5.3.3 Facilities

The hatchery complex consists of a barrier dam and fish ladder, collection and holding tanks, enclosed spawning and early incubation facilities, grow out ponds, and fish transport vehicles.

Barrier Dam and Fish Ladder

The fish barrier dam diverts fish into a ladder leading to the hatchery. All fish are stopped at the barrier dam. When the gates are open, upstream migrating fish can move into the ½-mile long ladder leading to the hatchery. The ladder consists of a series of pools with a minimum width of six feet and a minimum depth of two feet. Flow velocity is two to five feet per second, and the maximum drop between pools is 1 foot. A chamber in the lower section of the ladder allows the public to view the migrating adult salmon and steelhead.

Gates to the fish ladder are generally open from about September first for the early spring run through the end of March for steelhead.

Adult Collection and Holding Facilities

Four concrete circular tanks at the head of the fish ladder collect and hold the adults until ready to spawn. Hatchery staff periodically examine the fish for signs of maturation.

Spawning Building

Mature fish are spawned in a separate building, and hatchery staff attempt to separate adult spring-run from adult fall-run. All chinook salmon are killed during the artificial spawning process.

Incubation

Fertilized eggs are moved to the building for incubation through hatching. In 2000, DWR completed an addition to the incubation facilities to provide a greater degree of separation for those chinook destined for planting in Lake Oroville. The new facilities include equipment for ultraviolet sterilization of the incoming water to minimize chances of disease in those fish that would be planted in the reservoir above the hatchery.

Rearing Channels

Fingerling chinook salmon and steelhead are reared in a series of outdoor, concrete-lined channels. The channels can be blocked at intervals to provide 48 individual pools of 100 by 10 feet. Water flow and velocity in the raceways are a nominal 5 cfs and 0.1 feet per second, respectively. DWR covered the raceways with a wire screen to limit depredation by birds.

Raceways at the Thermalito facility, located on the west side of the Thermalito Afterbay, are used to raise salmon fry susceptible to a coldwater virus (the Sacramento River coldwater disease); to achieve more rapid growth in the warmer waters; and to rear juvenile chinook for enhancement of the ocean and inland fisheries. Facility construction was through the California Salmon Stamp program, and DWR funds the operation.

Fish Transport Vehicles

Three vehicles, 1 of 500 gallons and two of 2,000 gallon capacity, are used to transport juvenile salmon and steelhead to planting locations in the Feather River, the Sacramento River, the Bay/Delta, and inland reservoirs, including Lake Oroville. The transport tanks are internally baffled to minimize physical damage to the juvenile salmon and are fully oxygenated. Ice and salt can be added to reduce transport stress.

4.5.3.4 Operations

General operations procedures are outlined in a 1999 DFG document governing their hatchery procedures in the Central Valley (DFG 1999). The following is a brief description of the three fish being reared at the Feather River Fish Hatchery.

Spring-Run Chinook Salmon

Spring-run chinook, with run designation based on the time adults enter freshwater, hold over in the Feather River during the summer. The fish ladder gates are typically opened in early September to allow adult spring run to enter the hatchery. The early entries are ready for spawning in October. Fish entering the hatchery after October 1 are generally considered fall run.

Hatchery staff collect sufficient males and females to provide the egg take and smolt production goals, taking into account the estimated losses through the rearing process. The goal is to have sufficient fish on hand to meet planting goals in the following spring with no surplus to handle.

To minimize disease problems, eggs for the inland reservoir program are generally collected from the early spawners. A pathologist examines the embryos for disease; if found disease free, the developing embryos are kept apart from the remainder of the hatchery production. This separation was formerly achieved by moving the fish to another hatchery, but facilities completed in 2000 allow the entire grow out process to occur at the hatchery.

Beginning in April, spring-run production fish are transported to a release site at the eastern end of San Pablo Bay. By this time, the young salmon have undergone a physiological transformation to enable them to enter saltwater and are called smolts.

Fall-Run Chinook

The same general operations guidelines apply to fall-run chinook; that is, taking spawners throughout the run, using more than 1 male to fertilize each female's eggs, and matching egg take to production goals. The major significant difference is that fall chinook eggs are allocated each year to enhancement production at the Thermalito and Mokelumne production facilities.

Enhancement fall-run chinook produced at Thermalito are trucked to San Pablo Bay with the other Feather River Fish Hatchery salmon production. Fish produced at the Mokelumne River facility are trucked separately to the same location.

Steelhead Rainbow Trout

Unlike chinook salmon, not all adult steelhead die after spawning; therefore, adult steelhead spawned at the hatchery are released alive. Hatchery steelhead are reared to the yearling stage and released in the Feather River. All steelhead production fish are marked with an adipose fin clip and a small, magnetic coded wire tag inserted in the head. The external fin clip allows anglers to determine quickly if the fish is of hatchery origin (and can be kept), and the coded wire tags allow biologists to determine if it originated at the Feather River Fish Hatchery.

Experimental Releases

A significant fraction of the Feather River fall and spring-run chinook salmon production is marked and released for experimental purposes. In the past few years, this fraction has been about 15 to 20 percent. Marking consists of clipping the adipose fins and inserting a specially coded magnetic tag in the head. Specific examples of the purposes of these releases are to:

- Evaluate the hatchery contribution to ocean and inland harvest, straying to other streams, and return to the Feather River;
- Evaluate the effects of stocking different sizes and numbers of chinook salmon on the Lake Oroville fish community and angler harvest;
- Evaluate factors influencing survival of chinook salmon through the Sacramento-San Joaquin Delta; and
- Evaluate different strategies for release of production fish in the Feather River, the Delta, and San Pablo Bay.

4.5.3.5 Evaluation of Hatchery Effectiveness

One approach to evaluating the hatchery is to examine the returns of steelhead and spring and fall chinook salmon to the Feather River before and after the Oroville Dam was closed in 1967. Reynold et al. (1993) indicated that, in terms of numbers of fish, the hatchery had achieved its mitigation responsibilities. The numbers shown are listed in Table 4.5-6.

Table 4.5-6: Feather River Salmon and Steelhead Returns Before and After Construction of Oroville Dam

	Steelhead	Spring Run	Fall Run
Goal	2000[a]	1700[b]	39,100[b]
Post dam	1454[c]	2800[d]	51,400[e]

(a) - hatchery mitigation goal.
(b) - pre-project estimate of run size.
(c) - 1982-1992 run size estimate. It also appears that several thousand steelhead are harvested in an intense in-river recreational fishery.
(d) - 1982-1992 run size estimate.
(e) - 1982-1992 run size estimate. There is also an estimated 10,000 fish in-river angler harvest (fall and spring runs combined).

In addition to the returns to the river, large of numbers of Feather River Fish Hatchery fish are caught by the ocean commercial and recreational fisheries. Two separate analyses (Dettman and Kelley 1987; Cramer 1992) estimated that the Feather River Fish Hatchery contributed about 20 percent of the chinook salmon harvested off the coast of California, or 100,000 to 200,000 fish in an average year. These analyses are being updated using returns of fish tagged at the hatchery over the past several years.

4.5.4 Lower Feather River

4.5.4.1 Habitat Description

The Low Flow Channel (LFC) extends eight miles from the Fish Barrier Dam to the Thermalito Afterbay Outlet (Figures 4.1-2 and 4.5-2). Under an agreement with the DFG, flows are regulated at 600 cfs, except during flood events when flows have reached as high as 150,000 cfs (DFG 1983). Average monthly water temperatures typically range from about 47ºF in winter to about 65ºF in summer. The majority of the LFC flows through a single channel contained by stabilized levees. Side-channel or secondary channel habitat is extremely limited. The channel banks and streambed consist of armored cobble as a result of periodic flood flows and the absence of gravel recruitment. However, there are nine major riffles with suitable spawning size gravel, and the majority of spawning takes place in this upper reach.

The Lower Reach (LR) extends 14 miles from the Thermalito Afterbay Outlet to Honcut Creek (See Figure 4.5-1). Releases from the outlet vary according to operational

Click here to access Figure 4.5-1

requirements. In a normal year, total flow in the LR ranges from 1,750 cfs in fall to 17,000 cfs in spring. Water temperature in winter is similar to the LFC but increases to 74ºF in summer. Higher flows dramatically increase the channel width in this reach. Numerous mid-channel bars and islands braid the river channel, creating side-channel and backwater habitat. The channel is not as heavily armored, and long sections of riverbanks are actively eroding. In comparison to the LFC, there is a greater amount of available spawning areas, which are isolated by longer and deeper pools.

4.5.4.2 Fish Species and Abundance

Overview

The Lower Feather River (LFR) from the Fish Barrier Dam to Honcut Creek supports a variety of anadromous and resident fish species. The two most important fish species in terms of sport fishing are the chinook salmon (*Oncorhynchus tshawytscha*) and the steelhead trout (*Oncorhynchus mykiss*), although striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissma*) are also common targets for anglers. Angler harvest estimates of Feather River chinook vary from year to year depending upon run strength and angler hours. Estimates for 1998 and 1999 were approximately 18,000 and 26,000 fish, respectively. Annual estimates of ocean catch of fall-run chinook from the Feather ranged between 40,000 and 90,000 between 1975 and 1984 (Cramer 1992). In addition to the sportfish mentioned above, several other native and exotic fish species are found in the Feather River. A list of fish commonly captured in both rotary screw traps is presented in Table 4.5-7. Because the game fishes mentioned above vary greatly in abundance on the LFR, each is treated separately in the discussion that follows.

Fall-Run Chinook Salmon

The chinook salmon is the most sought after sport fish on the LFR. Approximately 75 percent of the natural spawning currently occurs between the Fish Barrier Dam and the Thermalito Afterbay Outlet (RM 59-67), with approximately 25 percent of the spawning occurring between the Afterbay Outlet and Honcut Creek (RM 43-67) (DWR 1994). The fall-run may enter the river as early as April and begin spawning in September. Spawning typically continues through December, with October and November constituting the peak spawning months. Adults three years old typically dominate the run, but two-year old grilse are common and adults as old as seven may be present. Once the female deposits her eggs, they remain in the gravel for approximately 60-90 days, depending on water temperature (Healey 1991). Once the fry emerge from the gravel, they typically spend little time rearing in the river. The emigration period is generally

Table 4.5-7: List of Fish Species Captured in Rotary Screw Traps on the LFR.

Common Name	***Scientific Name***	**Native***
Pacific Lamprey	*Lamptera tridentata*	N
River Lamprey	*Lamptera ayresi*	N
American Shad	*Alosa sapidissima*	
Threadfin Shad	*Dorosoma petenense*	
Common Carp	*Cyprinus carpio*	
Golden Shiner	*Notemigonus crysoleucas*	
Hardhead	*Mylopharadon conocephalus*	N
Hitch	*Lavinia exilicauda*	N
Sacramento Squawfish	*Ptychocheilus grandis*	N
Speckled Dace	*Rhinichthys osculus*	N
Splittail	*Pogonychthys macrolepidotus*	N
Sacramento Sucker	*Catastomus occidentalis*	N
Black Bullhead	*Ameiurus melas*	
Brown Bullhead	*Ameiurus nebulosus*	
Wakasagi	*Hypomesus nipponensis*	
Brook Trout	*Salvelinus fontinalis*	
Chinook Salmon	*Oncorhynchus tshawytscha*	N
Steelhead (Rainbow) Trout	*Oncorhynchus mykiss*	N
Western Mosquitofish	*Gambusia affinis*	
Bluegill	*Lepomis macrochirus*	
Green Sunfish	*Lepomis cyanellus*	
Redear Sunfish	*Lepomis microlophus*	
Warmouth	*Lepomis gulosus*	
Pumpkinseed	*Lepomis gibbosus*	
Black Crappie	*Pomoxis nigromaculatus*	
White Crappie	*Pomoxis annularis*	
Largemouth Bass	*Micropterus salmoides*	
Smallmouth Bass	*Micropterus dolomieu*	
Redeye Bass	*Micropterus coosae*	
Spotted Bass	*Micropterus punctulatus*	
Bigscale Logperch	*Percina macrolepida*	
Tule Perch	*Hysterocarpus traski*	N
Prickly Sculpin	*Cottus asper*	N
Riffle Sculpin	*Cottus gulosus*	N

*An ‘N’ indicates a native species.

December through June, with the peak sometime between January and March (DWR unpublished data). A small number of fall salmon (5,000-15,000) may continue to rear in the river throughout the summer. Data on juvenile salmon abundance and emigration patterns have been obtained sporadically since 1955. Painter et al. (1977) used fyke nets to capture emigrating juvenile chinook salmon at Live Oak between 1968 and 1973. The DWR has been using rotary screw traps at Live Oak and Oroville since 1996 to monitor the abundance and timing of juvenile fall-run emigration. During the 1999-2000 rotary screw trap survey, 584,000 fall-run chinook salmon were captured. Trapping efforts will continue throughout the 2000/2001 emigration period. Although the methods of data collection have varied through time, nothing indicates that the timing of emigration has changed over the past 45 years.

Historic records for naturally spawning adult fall-run chinook have been kept since 1953 (see Spawning Escapement Survey). Fall-run abundance has stabilized and may have increased since the Oroville Project began operation in 1967, most likely due to hatchery supplements of naturally spawning stocks (DWR 1994). Feather River Fish Hatchery escapement estimates have ranged from a low of 1,856 (1967) to a high of 17,554 (1998), averaging approximately 8,000 fish/year.

Spring-Run Chinook Salmon

The basic life history of spring-run in the Feather River is very similar to fall-run, except that spring-run tend to arrive earlier in the year and spawn almost exclusively in the LFC. Spawning may also occur a few weeks earlier for spring-run (as compared to fall-run), but there is no clear distinction between the two. Emigration data on juveniles are as unclear as the spawning escapement data. High variability in numbers (race is delineated by a DWR modification of a DFG's daily length table for the Sacramento River) and emigration timing make any reliable emigration estimate problematic. As with fall-run, data on juvenile spring-run emigration timing and abundance have been collected sporadically since 1955. Painter et al. (1977) used fyke nets to capture juvenile salmon fry between 1968 and 1973 at Live Oak. Although Painter et al. (1977) did not sample in November, their results revealed that very few juvenile salmon were caught in December in each of the six years studied. The DWR has been using rotary screw traps to capture emigrating juvenile salmon at Live Oak and Oroville since 1996 (DWR 1999). This work has focused on sampling the entire emigration period (November-June) and its initial results suggest that November and December may be key months for spring-run emigration (DWR unpublished data). Although the recent spring-run data cannot be compared to past studies, they do allow future comparisons of spring-run abundance. Considering the normal variability in run timing, the lack of November data, and the differences in gear types used, it would be difficult to find any significant differences for emigration timing or abundance estimates between the year groups studied.

At present, the genetic distinctness of Feather River spring-run is still undetermined (Hedgecock et al. Unpublished data). Fish exhibiting the typical life history of the Northern California spring-run are found holding at the Thermalito Afterbay Outlet and the Fish Barrier Dam as early as March. Microsatellite analysis of the Feather River Fish Hatchery spring-run phenotype conducted by Bodega Marine Laboratories in recent years has revealed that Feather River chinook salmon are intermediate between spring and fall-run samples, but were most similar to Feather River Fish Hatchery fall-run. Despite the questionable genetic heritage of Feather River spring-run, NMFS still considers it part of the Central Valley spring-run Evolutionarily Significant Unit (ESU) because these fish "may retain some 'spring-run' life history characteristics." To further clarify the spring-run genotype on the Feather River, the DWR collected tissues from naturally produced juvenile spring-run salmon (as recorded according to the daily length table) in 1999 and from the earliest arriving adults in 2000. The results of these sampling efforts are still inconclusive. Further tissue sampling will continue to provide the most recent data for analysis.

As part of the tissue sampling, the DFG removes the head from any fish without an adipose fin (see Section 4.5.3.4 for a description of Feather River Fish Hatchery adipose fin clipping and coded wire tagging procedures). Heads taken from two coded wire tagged fish during tissue sampling (May 2000) revealed that these fish were tagged as juvenile spring-run in the Feather River Fish Hatchery in 1997. Conversely, other CWT data recovered at the Feather River Fish Hatchery have not proven to be as consistent. In some studies, as many as 20 percent of juvenile salmon tagged as spring-run at the Feather River Fish Hatchery were subsequently identified as fall-run when they returned to the hatchery as adults (DWR 1999). It is clear that more data are necessary to resolve this issue.

Historically, spring-run chinook used the Feather River. From 1954 through 1960, spring-run population estimates in the Feather River ranged from 500 to 4,000, averaging 2,314 fish/year. During project construction (1963-1966), DFG counts ranged from 297 (1966) to 2,908 (1964) adult spring-run, with an average of 1,136 fish/year. Post-

Oroville Feather River Fish Hatchery counts have ranged from a low of 146 to a high of 8,430, with an average 2,073 fish/year (DWR 1999). Since project inception, all spring-run counts have been based on salmon entering the Feather River Fish Hatchery. Except for 1946 and the years 1954-1960, no data are available for counts of naturally spawning populations in the Feather River. Based on the assumption that spring-run probably spawn as far upstream as possible and earlier than fall-run, super-imposition losses are probably the major factor affecting their in-channel survival (DWR 1999). Furthermore, the inability of the Feather River Fish Hatchery to accurately distinguish true spring-run from fall-run has undoubtedly accelerated the introgression that is occurring naturally within the river.

Steelhead

Most steelhead adults ascend the Feather River from September through January, where spawning takes place rather quickly. It is presumed that soon after spawning, those that survive the journey return to the ocean. It is currently unknown how long adult steelhead stay in the Feather River after spawning and what their post-spawning mortality is. Soon after emerging from the gravel, a small percentage of the fry appears to emigrate. The remainder of the population appears to rear in the river for at least six months to 1 year. Little data exist on the residence time of juvenile steelhead in the Feather River. DWR studies are currently underway to gather more information on juvenile rearing and emigration behavior.

Prior to the construction of Oroville Dam, most Feather River steelhead spawned upstream of the town of Oroville. DFG counts made during project construction (1963-1967) ranged from a low of 416 (1963) to a high of 914 (1965), and averaged 582 adult fish/year (Painter et al. 1977). Feather River Fish Hatchery counts between 1969 and 1998 ranged from a low of 78 (1971) to a high of 2,587 (1988), with an average of 904 adults/year (DWR 1999). The Feather River Fish Hatchery is currently placing an individual coded wire tag in all hatchery produced steelhead and marking each with an adipose fin clip. As fish return and tags are recovered, our understanding of Feather River steelhead life history will improve.

Aside from the counts made during project construction, no data are available on escapement of naturally spawning steelhead in the Feather River. Because steelhead do not necessarily die after spawning, traditional escapement estimates cannot be used to estimate abundance. Dive surveys are being conducted by the DWR to gather more information on the number of naturally spawning steelhead and their habitat preferences within the Feather River.

It appears that most of the natural spawning in the Feather River occurs in the Low Flow Channel. It is unknown whether steelhead spawn below the Thermalito Afterbay Outlet. Anglers report catching adults downriver of the outlet, but it is possible that steelhead are simply being caught as they move toward the LFC to spawn. Based on the spawning habitat available, it is very likely that at least some steelhead spawn below the Afterbay Outlet. Generally, between 100 and 150 juvenile steelhead parr are trapped at the Thermalito screw trap in March and April. The lower catch at the Live Oak screw trap however, indicates that either steelhead spawning is much less in the Lower Reach or that juveniles tend to rear longer in this portion of the river and grow to a size more capable of avoiding the trap. Recent dive surveys directed at adult steelhead in the Lower Reach are inconclusive (DWR unpublished data). Due to high flows and poor visibility during steelhead spawning in the Lower Reach, adults are difficult to see. However, consistent dive surveys directed at juvenile steelhead in the Lower Reach indicate that there are very few rearing in this portion of the river, indicating a low level of spawning activity.

Recent studies have also confirmed that juvenile rearing (and probably adult spawning) is most concentrated in small secondary channels within the LFC (DWR unpublished data). The smaller substrate size and greater amount of cover provided by these side channels (compared to the main river channel) probably make them a suitable area for steelhead spawning. Currently, this type of habitat comprises less than 1 percent of the available habitat in the LFC.

The Feather River also appears to have a run of steelhead that migrates into the river in the spring, presumably to spawn. Recent studies (DWR unpublished data) indicate that at least some spring and summer spawning is occurring in the LFC, but more data must be collected to verify this trend. Studies are currently underway to research this question.

Striped Bass

The pre- and post-project status of the striped bass fishery on the Feather River has not been well documented. Painter et al. (1977) determined that the striped bass fishery was good in some pre-project years but had considerable year-to-year variation. They also reported that striped bass spawning was not significant in the Feather River and that lower spring flows and higher spring temperatures resulting from project operation will reduce the likelihood that a viable fishery will develop. From 1972-74, Painter et al. conducted a creel census between the Thermalito Afterbay Outlet and Verona to estimate angler success in different portions of the river. Although the section between the Thermalito Afterbay Outlet and Live Oak was used, it did not appear to be as popular as the sections between Marysville and Verona.

The DFG conducts a creel census on the Feather River. To the best of our knowledge, there are currently no studies that focus solely on the striped bass fishery in the Feather River.

American Shad

The pre- and post-project status of the American shad fishery on the Feather River has not been well documented. However, the number of pre-project spring shad anglers indicates that the fishery was extremely important and had been termed excellent by some (Painter et al. 1977).

Painter et al. (1977) studied how the Oroville Project would affect the spring temperature regimen of the Feather River and, consequently, American shad spawning. They determined that pre-project flows and temperatures attracted enough American shad to support an excellent fishery. They also determined that changes in the temperature regimen since project construction may have an adverse effect on the extent of shad migration into the Feather River. Although most of their data on spawning and fishing effort were collected between Marysville and Verona, a portion of their creel survey was conducted between the Thermalito Afterbay Outlet and Live Oak. It appeared that this portion of the river was very significant in terms of fishing effort and angler success, often providing the greatest catch/angler hour.

Current data on migration timing of American shad from DWR rotary screw trap sampling and snorkel surveys are limited. The DFG also conducts a creel census on the Feather River, but it is not used to manage the shad fishery. To the best of our knowledge, there are currently no studies that focus solely on the American shad fishery in the Feather River.

4.5.5 Oroville Wildlife Area

The Oroville Wildlife Area (OWA) contains over 75 warmwater ponds and sloughs, along with vast complexes of emergent marsh and flooded cottonwood, willow, and sycamore trees. Largemouth bass, channel catfish, white catfish, bluegill, green sunfish, and carp are all highly abundant, along with populations of black and white crappie as well. The fish are replenished through natural reproduction in the ponds, and from the Feather River, which floods into the OWA every few years.

The OWA provides access to the majority of the upper reaches of the mainstem Feather River, which is the most popular area for steelhead and salmon fishing on the river. The Thermalito Afterbay Outlet, located within the OWA, is the most popular fishing spot in Butte County, hosting tens of thousands of anglers each year.

4.6 BOTANICAL RESOURCES

The botanical resources of the project are described in this section. Approximately half, or just over 21,100 acres, of the area within the FERC boundary is covered by surface waters. The remaining 20,000 acres consist of native vegetation, developed areas (e.g., project facilities, including recreational developments), and other disturbed areas. Significant areas of native vegetation occur within the areas surrounding Lake Oroville and in the lower elevations associated with the Fore and Afterbays and the Feather River. Approximately 4,000 acres of the terrestrial areas are lands managed by the USFS or the Bureau of Land Management (BLM).

4.6.1 Project Area

4.6.1.1 Vegetation Types

Maps of the general vegetation of the project area are presented in Figures 4.6-1a through 4.6-1d. These maps were compiled using land-cover maps generated by the California GAP Analysis Project (CGAP 2000). The GAP maps were produced at a low spatial detail (1:100,000) to provide a broad overview of the distribution of major terrestrial plant communities and vertebrate species habitats and were not meant as a detailed biological inventory. The minimum mapping unit for upland land-cover was 247 acres, and 99 acres for wetlands. GAP Analysis used the classification system in use at that time by the California Natural Diversity Database (CNDDB). Classes were added for land-cover types not well represented in the CNDDB classification system, such as wetlands and non-vegetated surfaces. Recently, the CNDDB has adopted a new classification system (Sawyer and Keeler-Wolf 1995) that is currently in use by federal, state, regional, and local agencies around California.

In general, the vegetation types within the Oroville Facilities project area are dominated by chaparral shrubs/woodland types or grassland/riparian types. The vegetation types within the project area based on the Sawyer and Keeler-Wolf classification system are listed in Table 4.6-1. The project facilities, which are situated within the foothill zones of the Sierra Nevada mountains (specifically Lake Oroville and the Thermalito Diversion Pool) are surrounded by chaparral species which may have emergent conifer or hardwood trees, or by tree cover with various degrees of understory development. These vegetation types may change abruptly or gradually along a gradient depending on the environmental conditions. The type of vegetation cover is determined by multiple factors including slope, aspect, soil type and depth, and fire history of the site. The project facilities within the Sacramento Valley are surrounded by grasslands, wetlands, and riparian areas, as well as disturbed areas.

The dominant vegetation types in the vicinity of Lake Oroville and the Thermalito Diversion Pool are tree series (oak series and conifer series), and shrub series (deerbrush series, wedgeleaf ceanothus series, and whiteleaf manzanita series). Vegetation cover within the various shrub series consists of low-growing (3-4 meters) evergreen species such as deerbrush (*Ceanothus integerrimus*), wedgeleaf ceanothus (*C. cuneatus*), whiteleaf manzanita (*Arctostaphylus viscida*), toyon (*Heteromeles arbutifolia*), coffeeberry (*Rhamnus californica*), chamise (*Adenostoma fasciculatum*), and ocean spray (*Holodiscus discolor*). Emergent conifers, such as ponderosa pine (*Pinus ponderosa*), foothill pine (*P. sabiniana*), and occasionally incense cedar (*Calocedrus decurrens*) may be present. The shrub cover is usually continuous but may be intermittent; the ground layer is usually sparse. The various shrub series are found on steep slopes and ridges.

These vegetation types are not considered rare; however, they do provide habitat for a number of the sensitive plant species of the region.

Shrub species are almost always present as understories within the various tree series. Dry slopes of all aspects support ponderosa pine and foothill pine series. Other tree species found within these series include blue oak (*Quercus douglasii*), canyon live oak (*Q. chysolepis*), black oak (*Q. kelloggii*), interior live oak (*Q. wizlizenii*), incense cedar, sugar pine (*P. lambertiana*), California buckeye (*Aesculus californica*), and Douglas-fir (*Pseudotsuga menziesii var. menziesii*). Blue oak, interior live oak, and canyon oak are present as pure stands or as stands of the mixed oak series.

Click here to access Figure 4.6-1a

This page was left blank intentionally.

Click here to access Figure 4.6-1b

This page was left blank intentionally.

Click here to access Figure 4.6-1c

This page was left blank intentionally.

Click here to access Figure 4.6-1d

This page was left blank intentionally.

Table 4.6-1: Vegetation Types Within Oroville Facilities Project Area

Series* dominated by trees:
Black Willow Series Blue Oak Series California Buckeye Canyon Live Oak Series Douglas-Fir Series ** Douglas-Fir-Ponderosa Pine Series ** Douglas-Fir-Tan Oak Series ** Foothill Pine Series Fremont Cottonwood Series Interior Live Oak Series Mixed Conifer Series Mixed Oak Series Ponderosa Pine Series Tanoak Series ** Valley Oak Series
Series* dominated by shrubs:
Buttonbush Series Deerbrush Series Mexican Elderberry Series Wedgeleaf Ceanothus Series Whiteleaf Manzanita Series
Series* without tree or shrub dominance:
Bulrush Series California Annual Grassland Series Cattail Series Northern Hardpan Vernal Pools Purple Needlegrass Series Sedge Series Spikerush Series
Miscellaneous Classifications:
Cropland Gravel tailings Lacustrine Orchard Riverine Urban
* Classification of Sawyer & Keeler-Wolf 1995 **Series which commonly occur within the highest elevations of the project area

Blue oaks also form savannas with open grassland areas on gentle to steep slopes. Tree species which are more common in shaded canyons or adjacent to riparian areas of the upper project area include tan-oak (*Lithocarpus densiflora*), madrone (*Arbutus menziesii*), California bay (*Umbellularia californica*), dogwood (*Cornus* spp.), and big leaf maple (*Acer macrophyllum*).

Narrow riparian areas are found throughout the steep canyons surrounding Lake Oroville. Typical species include willows (*Salix* spp.), cottonwood (*Populus fremontii*), alder (*Alnus rhombifolia*), and California sycamore (*Platanus racemosa*).

Large areas of California annual grassland series are uncommon within the higher elevations surrounding Lake Oroville. These stands are dominated by non-native annual grass species such as bromes (*Bromus* spp.) and wild oats (*Avena* spp.), but native grasses are common throughout this area. The open grasslands within the Craig Saddle Recreation Area support large continuous stands of deergrass (*Muhlenbergia rigens*), and small stands of purple needlegrass (*Nassella pulchra*) are present throughout the upper project area.

The lower elevations of the project area are dominated by the California annual grassland series, which typically consists of non-native species such as bromes, wild oats, medusa head (*Taeniatherum caput-medusae*) and star thistle (*Centaurea solstitialis*). Some of these areas have spectacular wildflower displays in the spring. Ephemeral wetlands of the sedge and spikerush series and northern hardpan vernal pools are present throughout these lower elevation grasslands. Vernal pools form in shallow depressions which are underlain with a clay layer or hardpan. The pools fill with rainwater during the fall and winter and may remain filled throughout the spring and summer. Vernal pool habitat is considered rare in the sense that much of the habitat has been eliminated on a state-wide basis; however, vernal pools are common throughout the lower portions of the project area (Figures 4.6-2). Portions of these vernal pools are in areas disturbed by the original construction of the project facilities. Other project areas still retain the gently undulating topography typically associated with vernal pools. Vernal pools provide habitat for a number of federally listed invertebrate and plant species. The endangered fairy shrimp (*Branchinecta lynchi*) has been identified within the California Department of Parks and Recreation's Clay Pit State Vehicle Recreation Area adjacent to the Thermalito Afterbay (Brittan 1996). Schlising and Sanders (1982) identified several listed plant species within the Richvale vernal pools, which are located at the western edge of the project area;

Click here to access Figure 4.6-2

This page was left blank intentionally.

however, no sensitive plant species were identified during a survey of a number of the vernal pools surrounding the Thermalito Afterbay (DFG 1995).

Sedge series wetlands occur throughout the drawdown zone of the Afterbay. These are dominated by rushes (*Juncus effusus*), verbena (*Verbena* spp.), bluestem grass (*Andropogon* sp.) and occasional stands of tules (*Scirpus* spp.). Other wetland types occur throughout the Oroville Wildlife Area and are discussed in Section 4.5.5.

The riparian vegetation of the lower Feather River is discussed in Section 4.6.2.

4.6.1.2 Sensitive Plant Resources

A search of the U.S. Fish and Wildlife Service (USFWS), DGF, USFS, and California Native Plant Society databases revealed no records of federally listed endangered or threatened plant species within the Oroville Facilities project area. However, four federally listed plant species do occur at locations adjacent to the project. Three of these species are listed as federally endangered. They include the Butte County meadow foam (*Limnanthes floccosa* ssp. *californica*), hairy orcutt grass (*Orcuttia pilosa*), and Greene's tuctoria (*Tuctoria greenei*). A fourth species, Hoover's spurge (*Chamaesyce hooveri*), is listed as federally threatened. These species occur in ephemeral wetland or vernal pools within grassland communities. Much of the land surrounding the forebay and afterbay facilities does, or at one time did, support this type of habitat.

Twenty plant species listed as federal Species of Concern are known to occur within or adjacent to the Oroville Field Division boundaries. This term includes former Category 2 candidate species and other plants of concern to the USFWS and other federal, state, and private conservation organizations. Two of these species are known to occur within the project boundaries. They include Mosquin's clarkia (*Clarkia mosquinii*) and Ahart's dwarf rush (*Juncus leiospermus* var. *ahartii*). An additional 15 plant species listed by the California Native Plant Society as high-priority species are known to occur in the area. Four of these species occur within the project boundary. They include fox sedge (*Carex vulpinoidea*), 4-angled spikerush (*Eleocharis quadrangulata*), Butte County calycadenia (*Calycadenia oppositifolia*), and Brandegee's clarkia (*Clarkia biloba* ssp. *brandegeae*). These species are not listed or currently proposed for listing, but their rarity warrants further investigation and they may be listed in the future. These species are listed in Table 4.6-2.

Table 4.6-2: Special Status Plant Species with Potential for Occurring within the Oroville Facilities Project Area

Scientific name **Common name**	**Status** **USFWS[1]**	**State[2]**	**CNPS[3]**	**Habitat (elevation)**	**Flowering period**
Chamaesyce hooveri Hoover's spurge	FT		1B	Vernal pools (<250m)	Jul
Limnanthes floccosa ssp. *californica* Butte County meadow foam	FE	SE	1B	Valley & foothill grassland (mesic), Vernal pools (<100m)	Mar-May
Orcuttia pilosa Hairy orcutt grass	FE	SE	1B	Vernal pools (<200m)	May-Aug
Tuctoria greenei Greene's tuctoria	FE		1B	Vernal pools (<200m)	May-Jul
Agrostis hendersonii Henderson's bent grass	SC		3	Valley & foothill grassland (mesic), Vernal pools (<300m)	Apr-May
Allium jepsonii Jepson's onion	SC		1B	Cismontane woodland, Lower montane coniferous forest/serpentinite or volcanic (300-600m)	May-Jun
Astragalus tener var. *ferrisiae* Ferris's milk-vetch	SC		1B	Meadows (vernally mesic), Valley & foothill grassland (subalkaline flats) (<60m)	Apr-May
Atriplex cordulata Heartscale	SC		1B	Chenopod scrub, Valley & foothill grassland (sandy)/saline or alkaline (<200m)	May-Oct
Calystegia atriplicifolia ssp. *Buttensis* Butte County morning glory	SC		1B	Lower montane coniferous forest (600-1200m)	May-Jun
Clarkia mosquinii ssp. *mosquinii* Mosquin's clarkia	SC		1B	Cismontane woodland (+/-500m)	May-Jul
Clarkia mosquinii ssp. *xerophila* Enterprise clarkia	SC		1B	Cismontane woodland, Lower montane coniferous forest (185m)	May-Jul
Cypripedium fasciculatum Clustered lady's slipper	SC			Lower montane coniferous forest, North coast coniferous forest/usually serpentinite seeps and stream beds (100-1700m)	Mar-Jul
Delphinium recurvatum Recurved larkspur	SC		1B	Chenopod scrub, Cismontane woodland, Valley & foothill grassland/alkaline (30-600m)	Mar-May

Fritillaria eastwoodiae Butte County Fritillary	SC	3	Chaparral, Cismontane woodland, Lower montane coniferous forest (openings)/sometimes serpentine (500-1500m)	Mar-May
Fritillaria pluriflora Adobe lily	SC	1B	Chaparral, Cismontane woodland, Valley & foothill grassland/often adobe (<500m)	Feb-Apr
Juncus leiospermus var. *ahartii* Ahart's dwarf rush	SC	1B	Vernal pools (50-100m)	Mar-May
Monardella douglasii ssp. *venosa* Veiny monardella	SC	1B	Valley & foothill grassland (heavy clay) (<400m)	May
Myosurus minimus ssp. *apus* Mousetail	SC		Vernal pools (alkaline) (<1500m)	Mar-Jun
Paronychia ahartii Ahart's paronychia	SC	1B	Cismontane woodland, Valley & foothill grassland, Vernal pools (<500m)	Apr-Jun
Penstemon personatus Closed-throated beardtongue	SC	1B	Lower montane coniferous forest, Upper montane coniferous forest/metavolcanic (1500-1800m)	Jul-Sep
Sagittaria sanfordii Sanford's arrowhead	SC	1B	Marshes & swamps (assorted shallow freshwater) (<300m)	May-Aug
Sanicula tracyi Tracy's sanicle	SC	4	Cismontane woodland, Lower montane coniferous forest, Upper montane coniferous forest/openings (100-1000m)	Apr-Jul
Sidalcea robusta Butte County checkerbloom	SC	1B	Chaparral, Cismontane woodland, (100-1600m)	Apr-Jun
Silene occidentalis ssp. *Longistipitata* Butte County catchfly	SC		Chaparral, Lower montane coniferous forest (1000-2000m)	Jul-Aug
Atriplex depressa Brittlescale		1B	Chenopod scrub, Valley & foothill/ alkaline or clay, Playas (<200m)	May-Oct
Atriplex minuscule Lesser saltscale		1B	Chenopod scrub, Valley & foothill grassland/alkaline, Playas (<200m)	May-Oct
Balsamorhiza macrolepis var. *macrolepis* Big-scale balsamroot		1B	Cismontane woodland, Valley & foothill grassland /sometimes serpentinite (<1400m)	Mar-Jun

Calycadenia oppositifolia Butte County calycadenia	1B	Chaparral, Cismontane woodland, Valley & foothill grassland/volcanic or serpentinite (<900m)	Apr-Jun
Carex vulpinoidea Fox sedge	2	Marshes & swamps, Riparian woodland (<1200m)	Jun
Clarkia biloba ssp. *Brandegeae* Brandegee's clarkia	1B	(<500m)	
Clarkia gracilis ssp. *Albicaulis* White-stemmed clarkia	1B	Chaparral, Cismontane woodland/ sometimes serpentinite (+/-500m)	May-Jul
Eleocharis quadrangulata Four-angled spikerush	2	Marshes & swamps (freshwater) (<500m)	Jul-Sep
Hibiscus lasiocarpus Rose-mallow	2	Marshes & swamps (freshwater) (<40m)	Aug-Sep
Juncus leiospermus var *leiospermus* Red Bluff dwarf rush	1B	Chaparral, Cismontane woodland, Valley & foothill grassland, Vernal pools/vernally mesic ((280-500m)	Mar-May
Lewisia cantelovii Cantelow's lewisia	1B	Broadleafed upland forest, Chaparral, Cismontane woodland, Lower montane coniferous forest/mesic, granitic, sometimes serpentinite seeps(400-1300m)	May-Jun
Lupinus dalesiae Quincy lupine	1B	Lower montane coniferous forest, Upper montane coniferous forest/often in disturbed areas (1000-2500m)	May-Jul
Sedum albomarginatum Feather River stonecrop	1B	Chaparral, Lower montane coniferous forest (serpentinite) (300-900m)	Jun
Senecia eurycephalus var *lewisrosei* Cut-leaved ragwort	1B	Chaparral, Cismontane woodland, Lower montane coniferous forest/serpentinite	Apr-Jul
Trifolium jokerstii Butte County golden clover	1B		

[1] United States Fish and Wildlife Service: FE - federal endangered, FT - federal threatened, SC - federal Species of Concern.
[2] California Department of Fish and Game: SE – state endangered
[3] California Native Plant Society: List 1B – plants rare, threatened, or endangered in California and elsewhere; List 2 - plants rare, threatened, or endangered in California but more common elsewhere; List 3 - plants about which more information is needed; List 4 - plants of limited distribution.

The surrounding area also includes a number of species listed by the California Native Plant Society as List 4 species or by the USFS as Special Interest species (Table 4.6-3). These plants are considered to be limited in distribution and may warrant a higher listing in the future. Each of these seven species is known to occur nearby, however, at higher elevations than occur within the Oroville Facilities project area.

A map of approximate sensitive plant locations that occur within or near the project area is shown in Figure 4.6-3. These locations were derived from California Natural Diversity Database (CNDDB) and USFS records.

Table 4.6-3: Low Priority Special Status Plant Species with Potential for Occurring within the Oroville Facilities Project Area

Scientific name **Common name**	**Status** **CNPS[1]**	**Habitat (elevation)**	**Flowering Period**
Allium sanbornii var. *sanbornii* Sanborn's onion	4	Chaparral, Cismontane woodland, Lower montane coniferous forest/serpentinite or volcanic (300-1400m)	Apr-Jul
Bulbostylis capillaris Hair-like bulbostylis	4	(>1000m)	
Clarkia mildrediae Mildred's clarkia	4	Lower montane coniferous forest (500-1600m)	Jun-Jul
Erigeron petrophilus var. *sierrensis* Northern Sierra daisy	4	Cismontane wilderness, Lower montane coniferous forest, Upper montane coniferous forest/sometimes serpentinite (300-1900m)	Jun-Sep
Lilium humboldtii ssp.. *humboldtii* Humboldt lily	4	Chaparral, Lower coniferous forest/ openings (600-1100m)	Jun-Jul
Stellaria obtuse Obtuse starwort	4	Upper montane coniferous forest, (mesic) (1600-2000m)	Jul
Viola tomentosa Wooly violet	4	Lower montane coniferous forest, Subalpine coniferous forest, Upper montane coniferous forest/gravelly (1500-2000m)	May-Aug

[1] California Native Plant Society: List 4 – plants of limited distribution.

4.6.1.3 Noxious Weed Issues

A number of plant species considered noxious weeds occur near or within the project area (Table 4.6-4). These non-native plants are aggressive invaders that displace native vegetation and associated wildlands, decrease water flow and quality, disrupt irrigation systems, and diminish recreational areas. The Butte County Weed Management Area, a local agency coordinated by the County Agricultural Commissioner's Office, considers four of these plant species high priority target species. They include purple loosestrife (*Lythrum salicaria*), giant reed (*Arundo donax*), yellow starthistle (*Centaurea solstitialis*), and parrot's feather (*Myriophyllum aquaticum*).

Current control/eradication projects in the vicinity of Lake Oroville include efforts by the DWR, the DFG, the DPR, the California Department of Transportation (Caltrans), the Butte County Department of Agriculture (BCDA), and local irrigation districts. These include purple loosestrife control within the Forebay and Oroville Wildlife Area by DWR, DFG, and DPR as well as and biological and mechanical control outside the project area by Caltrans and BCDA. Other control efforts near the project area include yellow star thistle by Caltrans and the BCDA; chemical treatment of giant reed by DFG; chemical treatment of skeleton weed by the BCDA; chemical treatment of parrot's feather by DFG and local irrigation districts; and general control using chemical and mechanical efforts by the irrigation districts. The Butte County Weed Management Area has recently been awarded a matching grant through California State University Chico. This program will establish a noxious weed database for Butte County.

4.6.1.4 Culturally Important Plant Species

A number of culturally important plant species occur with the project area. These species were used for a variety of purposes including food, shelter, clothing, tools, medicine, rituals and ceremonies. Important food plants which are common throughout the upper project area include pines (*Pinus* spp.), oaks (*Quercus* spp.), buckeye (*Aesculus californica*), cattail (*Typha* spp.), hazelnut (*Corylus cornuta* var. *californica*), and berries (*Rubus* spp.).

Species used in basketry are common throughout the project area and include redbud (*Cercis occidentalis*), willow, and maidenhair fern (*Adiantum* spp.). The botanical resources staff will obtain a list of such species from the cultural resources working group and, if requested, will identify and map all significant stands of these species.

Click here to access Figure 4.6.3

Click here to access Figure 4.6-4

Table 4.6-4: Known or Potential Noxious Weed Species that Occur Within or Near the Oroville Facilities Project Area

Scientific Name **Common Name**	**List[1]**	**Habitat (elevation)**
Ailanthus altissima	A	Disturbed urban areas, waste places,
Tree of heaven		Riparian areas, grasslands (<1250m)
Arundo donax	A	Moist places, seeps, ditchbanks
Giant reed		(<500m)
Centaurea maculosa	A	Disturbed areas (<2000m)
Spotted knapweed		
Linaria genistifolia ssp. *Dalmatica*	A	Disturbed places, pastures, fields
Dalmation toadflax		(gen <1000m)
Cardaria chalepensis	B	Disturbed, gen saline soils,
Lens-podded hoarycress		fields (<1500m)
Cardaria pubescens	B	Saline soils, fields, ditchbanks
Whitetop		(<2000m)
Cirsium arvense	B	Disturbed places
Canada thistle		(<1800m)
Lepidium latifolium	B	Saline soild, roadsides
Broad-leaved peppergrass		(<1900m)
Lythrum salicaria	B	Marshes, ponds, streambanks
Purple loosestrife		ditches (<1000m,
Myriophyllum aquaticum	B	(<500m)
Parrot's feather		Ponds, ditches, streams, lakes,
Solanum elaeagnifolium	B	Dry, disturbed places
Hoary horsenettle		fields (<1200m)
Centaurea solstitialis	C	Pastures, roadsides, disturbed
Yellow starthistle		Grassland or woodland (<1300m)
Convolvulus arvensis	C	Orchards, gardens
Field bindweed		(gen <1500m)
Cynodon dactylon	C	Disturbed sites
Bermuda grass		(<900m)
Cytisus scoparius	C	Disturbed places
Scotch broom		(<1000m)
Genista monspessulana	C	Disturbed places
French broom		(<500m)
Hypericum perforatum	C	Pastures, abandoned fields,
Klamathweed		disturbed places (<1500m)
Salsola paulsenii	C	Disturbed places

Tumbleweed		(700-1800m)
Sorghum halepense Johnson grass	C	Disturbed areas, ditchbanks, roadsides (<800m)
Taenatherum caput-medusae Medusa head	C	Grasslands, particularly alkaline and poorly drained areas
Tribulus terrestris Puncturevine	C	Roadsides, railways, vacant lots, dry, disturbed areas (<100m)

[1]California Department of Food & Agriculture List of Noxious Weeds: List A - Most invasive wildland pest plants - eradication, containment or other holding action at the state-county level; List B - Includes species less widespread and more difficult to contain - eradication, containment, control or other holding action at the discretion of the Commissioner; List C – Weeds that are so widespread that the agency does not endorse state or county-funded eradication except in nurseries.

4.6.2 Lower Feather River

4.6.2.1 Riparian Vegetation Resources

The Lower Feather River (LFR) is that stretch of the Feather River from the Oroville Dam down to the confluence with the Sacramento River, for a distance of 78.3 river-miles. The LFR watershed, approximately 57 percent of the Feather River drainage, covers a total of 3,721 square miles and includes two major tributaries, the Yuba and the Bear rivers. Cities along the LFR include Oroville in the area of the Dam and Thermalito areas, and Yuba City and Marysville at the confluence of the LFR and the Yuba River.

Lake Oroville, the uppermost limit to the LFR, is the lowermost reservoir on the Feather River and the upstream limit for anadromous fish migration. Approximately five miles downstream of the Oroville Dam, water is diverted at the Thermalito Diversion Dam into the Thermalito Fore- and Afterbay system. Approximately eight miles downstream from the Diversion Dam, the Thermalito Afterbay Outlet releases the diverted water back into the LFR. Immediately downstream of the Outlet, the DFG administers the 5,700-acre Oroville Wildlife Area (OWA).

In the upstream portion, the LFR has been modified by the Dam and the Thermalito Diversion Dam to form the Thermalito Pool. The portion of the LFR between the Thermalito Diversion Dam and the Thermalito Afterbay Outlet flows at a constant 600 cfs (the Low Flow River Section), except during flood control operations. The LFR is constricted to its current course for much of its length by a levee system from the Diversion Dam downstream to its confluence with the Sacramento River. Commencing immediately downstream of the Diversion Dam, large dredge spoils bank areas further bolster the levee system. The LRF exhibits frequent scour areas, aggrading areas, and channelization

The LFR riparian zones will be examined through comparison of historical and current aerial photographs, from the decades prior to Oroville Dam and the decades following construction of the dam. The aerial photograph analysis will be ground-truthed for current conditions.

The LFR has been modified by various human activities. The riverine functions of the LFR have been dramatically reduced through the trapping of coarse sediment by the Oroville and Thermalito Dams and the maintenance of the constant low flows, creating down-cutting and increasing channelization. Throughout the LFR, sand- and gravel-bars have “fossilized” through colonization of riparian, and subsequently terrestrial, vegetation.

Consequently, the riparian vegetation of the LFR is fairly restricted or absent in many areas. The most extensive portions of the riparian zone are found within the OWA and south of Marysville. The riparian zone along the LFR has been generalized into eight types: agriculture, blackberry scrub, riparian scrub, herbaceous cover, disturbed riparian, cottonwood forests, valley oak forests, and mixed forests. Riparian resources are mapped on Figure 4.6-4.

The blackberry scrub type is dominated by blackberry, with little or no other groundcover vegetation. Scattered valley oaks and cottonwoods are dispersed through much of these areas. The riparian scrub is dominated by willows, usually interspersed with various grasses, terrestrial, and facultative species. The herbaceous cover type is dominated by grasses, forbs, and scattered cottonwoods and oaks.

The forest types occur in the temporarily flooded areas within the levee system. The canopy consists of California sycamore, valley oak, with occasional minor constituents of other oaks, cottonwood, and maples. Typical understory species include white alder, Oregon ash, willows, and maples. Canopy closures range from 10 to 90 percent and understories are frequently dense. Groundcover, though generally lacking, usually consists of blackberry thickets.

The disturbed areas consist of the following habitat types: urban/residential, cropland, and dredge spoils. Urbanization affecting the LFR is found primarily within the City of Oroville. This includes bank hardening with riprap or concrete, channelization, bridge crossings, residential and commercial development, and run-off channels. The agricultural areas consist primarily of commercial orchards that extend to the top-of-bank zones within the riparian zone. These areas reduce or eliminate the riparian vegetation and could affect the riparian vegetation and riverine environments through agricultural runoff. The dredge spoil areas, remnants of past gold dredging, are found in the area of the OWA. These areas usually lack any riparian vegetation and are considered by wildlife biologists to be unsuitable as wildlife habitat.

4.7 WILDLIFE RESOURCES

Variability in slope, aspect, precipitation, elevation, hydrology, land use, and soil results in a diversity of wildlife habitats within and adjacent to the project area. These diverse habitat assemblages support a variety of wildlife species, including numerous recreational/commercial species as well as special status (sensitive species). Wildlife habitats within the project area are managed by several land management agencies including the USFS, BLM, DPR, DFG, and the DWR. Wildlife species occurrence in Butte County is presented in Appendix B.

4.7.1 Wildlife Habitats

The principal wildlife habitat types in the project vicinity include riverine, lacustrine (ponds and lakes), annual grassland, valley/foothill riparian, cropland, orchard/vineyard, urban/residential, emergent wetland, mixed chaparral, blue oak/foothill pine, montane hardwood/conifer, and ponderosa pine (see Figures 4.7-1 through 4.7-1d). In general, the wildlife habitat types within the Oroville Facilities project area are dominated by lacustrine, blue oak/foothill pine, and valley foothill riparian. Maps of the general wildlife habitats of the project area are presented in Figures 4.7.1a, 4.7.1b, 4.7.1.c and 4.7.1d. These maps were compiled using land-cover maps generated by the California GAP Analysis Project (http://www.biogeog.ucsb.edu/ projects/gap). The GAP maps were produced at a low spatial detail (1:100,000) to provide a broad overview of the distribution of major terrestrial plant communities and vertebrate species habitats and were not meant for a detailed biological inventory. The minimum mapping unit for upland land-cover was 247 acres and 99 acres for wetlands. GAP Analysis used the classification system developed for the California Wildlife Habitat Relationships Program (CWHR). Each CWHR habitat type may contain one or more of the plant

Click here to access Figure 4.7.1a

This page was left blank intentionally.

Click here to access Figure 4.7-1b

This page was left blank intentionally.

Click here to access Figure 4.7-1c

This page was left blank intentionally.

Click here to access Figure 4.7-1d

This page was left blank intentionally.

This page was left blank intentionally.

This page was left blank intentionally.

communities identified in Section 4.6.1.1. CWHR model predictions of wildlife species that could occur within these habitats in Butte County are included in Figure 4.7-1a through 4.71d.

Riverine habitat (streams and rivers) structure consists of open water (greater than two feet in depth), submerged near shore areas, and banks with less than 10 percent canopy cover (Mayer and Laudenslayer 1988). Waterfowl use open water areas for resting. Osprey, cormorants, and gulls forage in open water habitats. Shorebirds, including herons, egrets, and sandpipers, forage along the submerged near shore areas. Insectivorous species, including swallows and phoebes, forage over riverine habitat. Banks associated with riverine habitat can provide cover or nesting substrate for bank swallow, belted kingfisher, muskrat, and beaver. Riverine habitat occurs throughout the project area along the Feather River and its tributaries.

Lacustrine habitat includes lakes, reservoirs, and ponds greater than five acres in size containing standing water (Mayer and Laudenslayer 1988). Lacustrine habitat is subdivided into limnetic zone (deep open water), littoral zone (shallow water areas where light penetration occurs to the bottom), and shore (water border with less than two percent vegetative cover). Lacustrine habitat provides all of the life history requirements (reproduction, food, water, and cover) for 150 wildlife species in California (Mayer and Laudenslayer 1988). Waterfowl use open water areas for resting and feeding. Osprey, cormorants, bald eagle, mergansers, and gulls forage in open water habitats. Grebes, herons, and diving ducks forage in the littoral zone. Swallows, bats, and swifts forage over lacustrine habitat. Banks associated with lacustrine habitat can provide cover or reproductive habitat for the western pond turtle, river otter, and beaver. Lacustrine habitat is present in the project area at Lake Oroville, Thermalito Forebay, Thermalito Afterbay, and in ponded habitat along the Feather River.

Annual grassland habitat is primarily composed of annual grasses and forbs and occurs in areas receiving less than 40 inches of precipitation per year. Moist areas within annual grasslands can support perennial species like purple needlegrass and Idaho fescue. Vernal pools can occur in annual grassland habitat where depressions are underlain by impervious clay or hardpan soils. Annual grassland composition and structure are highly dependent upon precipitation and historic grazing practices. Common wildlife species include black-tailed jackrabbit, California ground squirrel, gopher snake, western fence lizard, California vole, badger, western kingbird, burrowing owl, horned lark, western meadowlark, Brewer's blackbird, American kestrel, turkey vulture, and northern harrier. Annual grassland habitat occurs around the Thermalito Forebay, Thermalito Afterbay, Power Canal, upland locations along the Feather River, and in isolated patches within the blue oak/foothill pine habitat around Lake Oroville.

Mature valley/foothill riparian habitat is structurally composed of a dominant deciduous overstory (California sycamore, valley oak, and cottonwood); an understory tree layer (white alder, Oregon ash); and a shrub layer (willows, poison oak, elderberries). Canopy closures range from 20 to 80 percent and understories are frequently dense. Herbaceous ground cover is generally lacking or limited to woodland openings. Riparian habitat provides food, water, cover, and reproduction areas for a wide variety of California wildlife species, including 50 reptiles and amphibians, 55 mammals, and 147 birds (Mayer and Laudenslayer 1988). Riparian habitat also provides migration and dispersal corridors and thermal cover for many species. Numerous wildlife species are largely dependent upon valley/foothill riparian habitat including red-shouldered hawk, western yellow-billed cuckoo, ringtail, yellow-breasted chat, and mink. Extensive stands of mature valley/foothill riparian habitat occur within the project area along the Feather River downstream from the community of Oroville. Narrow strips of riparian habitat also occur in association with the tributaries to Lake Oroville.

The cropland habitat in the project vicinity is monotypic, even-aged with 100 percent ground cover and little or no structural diversity. Waste grain following fall harvest is an important winter waterfowl food source. Representative species in local cropland habitats include ring-neck pheasant, sandhill crane, red-winged blackbird, giant garter snake, white-faced ibis, and muskrat. Cropland is an agricultural habitat type that occurs adjacent to the project area almost exclusively as rice cultivation. Less than 30 acres of dryland grain cropland habitat (DFG wildlife food/cover plantings) occur within the project area near the north end of the Thermalito Afterbay.

Orchard/vineyard habitat is generally even-aged, monotypic, and regularly spaced. Mature habitat exhibits high percent canopy closure and open understories with little or no ground cover. Common species in this habitat include American crow, western scrub jay, European starling, California ground squirrel, western gray squirrel, American robin, and mourning dove. Orchard/vineyard habitat is not present within the project area. A few acres of remnant orchard within the Oroville Wildlife Area have largely been overtopped by riparian tree and shrub species. However, areas adjacent to the project area along the Feather River portion of the Oroville Wildlife Area contain walnut, almond, and kiwi orchard/vineyard habitat.

Urban/residential habitat is structurally divided into five classes including tree grove, street strip, shade tree/lawn, lawn, and shrub cover (Mayer and Laudenslayer 1988). Urban/residential habitats frequently exhibit high structural diversity, high plant species diversity, and extensive edge areas. Both native and non-native plant species occur. However, non-native annual and perennial species are frequently dominant. Maintenance normally precludes community succession in urban/residential habitat. Common wildlife species associated with urban/residential habitat include European starling, house sparrow, rock dove, northern mockingbird, house finch, gopher snake, western fence lizard, striped skunk, and opossum. No urban/residential habitat exists within the project area. However, conversion of annual grassland, blue oak/foothill pine woodland, and valley/foothill riparian habitat to urban/residential habitat continues to occur on the perimeter of the project area.

Emergent wetland habitats are dominated by short, erect, rooted hydrophytes (cattail, tule bulrush) and occur in waters less than six feet in depth. Stands tend to be dense and structurally simple. Seasonal flooding restricts species diversity to those species adapted to anaerobic soil conditions. Emergent wetlands are a successional community developing from open water through time to upland habitat. Erosion rates control the rate of successional change. Freshwater emergent wetlands can provide habitat for over 160 species of birds in California as well as key habitat for numerous species of reptiles, amphibians, and mammals (Mayer and Laudenslayer 1988). Characteristic species include red-winged blackbird, short-eared owl, giant garter snake, mallard, muskrat, and bullfrog. Strips of emergent wetland habitat are found around the Thermalito Afterbay, Thermalito Forebay, within dredger ponds in the Oroville Wildlife Area, and in backwater areas along the Feather River. Emergent wetlands are generally absent within the drawdown zone of Lake Oroville or within the steeper drainages upslope from the reservoir.

Mixed chaparral is a fire dependent habitat dominated by evergreen shrub species with xerophytic adaptations. Fire is the dominant disturbance factor, and the length of time between burns largely controls the structure, composition, and density of mixed chaparral stands. Recently burned stands tend to be dominated by annual herbaceous species and shrub seedlings. In the period from 3 to 15 years after disturbance, shrubs increase in size and eliminate herbaceous ground cover as the shrub canopy closes. Older stands contain little or no ground cover with tall, dense, increasingly decadent shrubs of a few species. Common mixed chaparral wildlife species include dusky-footed woodrat, wrentit, California thrasher, black-tailed deer, blue-gray knatcatcher, and black-chinned hummingbird. Limited amounts of mixed chaparral habitat are present within the project area, primarily above 1,000 feet elevation. Chaparral stands are most common on south-facing slopes and less productive, shallow soils. Mixed chaparral habitat is commonly interspersed within blue-oak/foothill pine and ponderosa pine habitats above 900 feet elevation.

Blue oak/foothill pine habitat exhibits high structural and plant species diversity due to the presence of multi-layered tree canopies, shrub understory, and herbaceous ground cover. Blue oaks grow slowly and regeneration is rarely observed in grazed stands. Approximately 130 wildlife species are known to use this habitat type for reproduction in the western Sierra Nevada (Mayer and Laudenslayer 1988). Common wildlife species include western fence lizard, western rattlesnake, acorn woodpecker, plain titmouse, western bluebird, black-tailed deer, Cooper’s hawk, wild turkey, and lark sparrow. Blue oak/foothill pine habitat is the most common terrestrial habitat type in the project area above 900 feet elevation.

Within mature montane conifer/hardwood habitat, at least 30 percent of the tree layer is comprised of conifers, and at least 30 percent is deciduous or evergreen hardwoods. The combination of conifers and hardwoods results in a multi-layered forest structure. Early seral stages contain a variety of shrub species, while mature stands often exhibit high canopy closure rates and little understory vegetation. Representative wildlife species include California newt, Nashville warbler, yellow-rumped warbler, mountain quail, black-headed grosbeak, and black bear. Discontinuous patches of montane hardwood/conifer habitat are present within the project area. This habitat is most common on north-facing slopes on the upper arms of Lake Oroville. This habitat becomes increasingly common at higher elevations upslope from the project area.

Ponderosa pine habitat includes those areas where ponderosa pine comprises at least 50 percent of the canopy. Often other conifer species occur in the overstory, and a hardwood and a shrub layer are present at lower elevations. Ponderosa pine habitat exhibits high plant species and structural diversity. Regular ground fire is necessary to maintain mature ponderosa pine habitat. In the absence of fire, this habitat is successional to mixed conifer or white fir habitats. Mature and overmature ponderosa pine provides nesting habitat for bald eagle and osprey. Ponderosa pine habitat supports a wide variety of woodpecker species can be an important migratory habitat for black-tailed deer. Individual ponderosa pine trees are common around Lake Oroville above 1,200 feet elevation. However, only relatively small, widely distributed areas exist within the project area where ponderosa pine comprises 50 percent of the canopy.

4.7.2 Commercially and Recreationally Important Species

The project vicinity provides seasonal or year-round habitat for a variety of commercially or recreationally important wildlife species (Table 4.7-1). Black-tailed deer are an important big game species in eastern Butte County. The project area contains a portion of the winter range of two migratory deer herds (Bucks Mountain and Mooretown herds), as well as a small resident population. Beginning in the 1960s, California deer herds began to exhibit decreasing population trends (Longhurst et al. 1976). The Bucks Mountain herd has followed this statewide trend with population decreases of 59 percent between the mid 1960s and early 1980s. The herd's status since the 1980s is unquantified (Henry Lomeli, DFG pers. comm.). The Mooretown herd exhibited a similar but less drastic population decline during the same time period.

Approximately ten percent of the winter range of both herds is publicly owned and managed by the USFS, BLM, and DPR. Private timber companies manage another ten percent of the winter range. The remainder of the winter range is privately owned and subject to various land uses including residential and grazing uses. Rural residential development (primarily on the winter range) is considered the major limiting factor on both deer herds (Snowden 1984). However, other factors have also contributed to the population decline including vegetative type conversion on timber lands, brush control or eradication using herbicides, loss of riparian areas, low fawn survival, fire suppression, and competition with livestock for forage. Limited big game hunting opportunities exist for black bear and feral pig on lands adjacent to the project area.

Waterfowl remain the most important (both commercial and recreational) group of wildlife in the lower elevation portions of Butte County. Lands managed for commercial grain production or natural wetlands support high wintering densities of ducks, geese, swans, and shorebirds. These lands also provide waterfowl nesting and brooding habitat as well. Waterfowl hunting access fees provide landowners with financial incentives to

Table 4.7-1. List of Commercially or Recreationally Important Wildlife Species that may Occur Within the Immediate Vicinity of the Oroville/Thermalito Project

Common Name	Scientific Name	Habitat
MAMMALS		
American badger	*Taxidea taxus*	AG, BO/FP
Beaver	*Castor Canadensis*	VFR, R, L
Black bear	*Urus americanus*	PP, MC, MH/C
Black-tailed hare	*Lepus californicus*	AG
Bobcat	*Felis rufus*	All terrestrial
Brush rabbit	*Sylvilagus bachmani*	MC, VFR
Coyote	*Canis latrans*	All terrestrial
Desert cottontail	*Sylvilagus audubonii*	AG, BO/FP
Douglas tree squirrel	*Tamiasciurus douglasii*	PP, MH/C
Ermine	*Mustela erminea*	PP, MH/C
Gray fox	*Unocyon cinereoargenteus*	VFR, MC, BO/FP, PP, MH/C
Long-tailed weasel	*Mustela frenata*	PP, BP/FP, MC, VFR, MH/C
Mink	*Mustela vison*	R, VFR
Black-tailed deer	*Odocoileus hemionus*	VFR, PP, BO/FP, MC, MH/C
Raccoon	*Procyon lotor*	All terrestrial
Striped skunk	*Mephitis mephitis*	All terrestrial
Virginia opossum	*Didelphis virginina*	AG, FEW,VFR
Western gray squirrel	*Sciurus griseus*	BO/FP, PP, VFR, MH/C
Western spotted skunk	*Spilogale gracilis*	MC, VFR, BO/FP, MH/C
Feral pig	*Sus scrofa*	AG, BO/FP, VFR
AMPHIBIANS		
Bullfrog	*Rana catesbeiana*	FEW, R, L
BIRDS		
American coot	*Fulica Americana*	AG, FEW
American crow	*Corvus brachyrhynchos*	AG, CR, U, O/V
American wigeon	*Anas Americana*	FEW, R, L, AG
Band-tailed pigeon	*Columba fasciata*	MH/C
Barrow’s goldeneye	*Bucephala islandica*	FEW, R, L
Blue-winged teal	*Anas discors*	FEW, AG, L, R
Bufflehead	*Bucephala albeola*	FEW, L, R
California quail	*Callipepla californica*	VFR, MH/C, AG, BO/FP, U, MC
Canada goose	*Branta Canadensis*	R, FEW, AG, L, C
Canvasback	*Aythya affinis*	FEW, L
cinnamon teal	*Anas cyanoptera*	FEW, L
common goldeneye	*Bucephala merganser*	R
common merganser	*Mergus merganser*	R, L, FEW
common snipe	*Gallingo gallingo*	FEW, C
Eurasian wigeon	*Anas Americana*	FEW, L, R, AG
Gadwall	*Anas strepera*	FEW, L, R
greater white-fronted goose	*Anser albifrons*	FEW, AG, C

green-winged teal	*Anas crecca*	FEW, L, R
hooded merganser	*Lophodytes cucullatus*	FEW, L, R
lesser scaup	*Aythya affinis*	FEW, L
Mallard	*Anas platyrhynchos*	FEW, R, L, C
mountain quail	*Oreortyx pictus*	VFR, MC, MH/C
mourning dove	*Zenaida macroura*	AG, VFR, BO/FP, R, C, U
northern pintail	*Anas acuta*	FEW, L
northern shoveler	*Anas clypeata*	FEW, AG, L,C
Redhead	*Aythya Americana*	FEW, L
ring-necked duck	*Aythya collaris*	L, R
ring-necked pheasant	*Phasianus colchicus*	FEW, AG, C
Ross' goose	*Chen rossii*	FEW, AG, C
ruddy duck	*Oxyura jamaicensis*	FEW, L, R
Snow goose	*Chen caerulescens*	FEW,C
tundra swan	*Cygnus columbianus*	L,AG
wild turkey	*Melaegris gallopavo*	BO/FP, MH/C, PP, VFR
wood duck	*Aix sponsa*	L,R,

HABITAT KEY	
C=cropland	AG=annual grassland
VFR=valley/foothill riparian	MH/C=montane hardwood/conifer
MC=mixed chaparral	R=riverine
FEW= freshwater emergent wetland	U=urban/residential
L=lacustrine	BO/FP=blue oak/foothill pine
O/V=orchard/vineyard	PP=ponderosa pine

manage for wintering waterfowl. Portions of the Oroville Wildlife Area within the project boundary are managed by the DFG to provide habitat for nesting and wintering waterfowl. Approximately two percent of the recreational use of this wildlife area is related to waterfowl hunting. The Thermalito Afterbay/Forebay Complex provides resting and foraging habitat for open water and diving waterfowl species (ruddy duck, bufflehead, scaup, ring-necked duck, common goldeneye, and common merganser), that is lacking in surrounding agricultural areas.

Upland game species (including mourning dove, wild turkey, ring-necked pheasant, and several species of quail) are found within the project area and provide hunting opportunities on adjacent private lands, as well as on some public lands including the Oroville Wildlife Area. Over 30 wild turkeys were harvested on the Oroville Wildlife Area last year (Andy Atkinson, DFG, Wildlife Area Manager, pers. comm.) Approximately two percent of the recreational use on the wildlife area is related to upland game bird hunting.

Numerous furbearers including badger, mink, beaver, raccoon, gray fox, weasel, muskrat, bobcat, and opossum may occur in the project vicinity. However, current commercial harvest of these species within the project area is believed to be negligible. Use of steel leg-hold traps is currently prohibited in California.

Non-consumptive uses (bird watching or nature study) are estimated to be greater than all wildlife related consumptive use combined within the project area on an annual basis. Students from local colleges, high schools, and elementary schools make use of the project area for nature/biological education and study.

4.7.3 Sensitive Species

Fifteen state or federally listed species (including candidate species) may occur within the project area (Table 4.7-2). Database and agency records indicate that southern bald eagle, peregrine falcon, greater sandhill crane, and valley elderberry longhorn beetle are known to occur within the project area. Aleutian Canada goose, bank swallow, Swainson’s hawk, western yellow-billed cuckoo, California red-legged frog, giant garter snake, and vernal pool fairy shrimp have been documented in the project vicinity. Limited amounts of potentially suitable habitat may exist within the project area for each of these seven species as well as vernal pool tadpole shrimp, and Conservancy fairy shrimp.

In addition to formally listed species, 17 BLM or USFS sensitive species may also occur in the project vicinity. Database and agency records indicate that tricolored blackbird, western burrowing owl, and southwestern pond turtle occur in the project area. However, potentially suitable habitat may exist within the project area for foothill yellow-legged frog, western spadefoot toad, California horned lizard, and all seven of BLM or USFS sensitive bat species.

4.7.4 Culturally Important Wildlife

Wildlife were used for food, clothing, shelter, tools, and ceremonial purposes by tribes in the Oroville area. Maidu and Konkow utilized most of the species available to them except coyote, dog, and wolf. Konkow also avoided consumption of bear, mountain lion, vultures, lizards, snakes, and frogs (Riddell 1978). Wildlife harvested as food frequently provided both clothing and tools. Elk, deer, bear, and smaller mammals provided hides for clothing and other purposes. Bone, hoofs, and or antlers were fashioned into tools. Small game (rabbits, quail, duck, geese, and other species) were snared. Feathers from

Table 4.7-2. List of Sensitive Wildlife Species that May Occur Within the Immediate Vicinity of the Oroville/Thermalito Project

Common Name	Scientific Name	Status	Habitat
BIRDS			
Aleutian Canada goose	*Branta canadensis leucopareia*	FT	FEW,C,L,AG
American bittern	*Botaurus lentiginosus*	FSC	FEW,C
American peregrine falcon	*Falco peregrinus anatum*	SE	All terrestrial
American white pelican	*Pelecanus erythrorhynchos*	CS	L,R
bank swallow	*Riparia riparia*	ST	R
Barrow's goldeneye	*Bucephala islandica*	CS	R,L
Bell's sage sparrow	*Amphispiza belli belli*	FSC	MC
Bewick's wren	*Thryomanes bewickii*	FSC	MC,VFR
black swift	*Cypseloides niger*	FSC	R
black tern	*Chlidonias niger*	FSC	FEW,C,R,L
California gull	*Larus californicus*	CS	L,R,C
California horned lark	*Eremophila alpestris*	CS, FSC	AG
California spotted owl	*Strix occidentalis caurina*	F,B,CS	MHC,PP
common loon	*Gavia immer*	CS, FSC	L,R
Cooper's hawk	*Accipiter cooperi*	CS	VFR,PP,MHC
double-crested cormorant	*Phalacrocorax auritus*	CS	L,R
ferruginous hawk	*Buteo regalis*	CS, FSC	AG,C
golden eagle	*Aquila chrysaetos*	CS	All terrestrial
greater sandhill crane	*Grus canadensis tabida*	ST	FEW,AG,C
hermit warbler	*Dendroica occidentalis*	FSC	MCH,PP,VFR
lark sparrow	*Chondestes grammacus*	FSC	BO/FP,VFR,MHR
Lawrence's goldfinch	*Carduelis lawrencei*	FSC	MC,BO/FP
least bittern	*Ixobrychus exilis hesperis*	CS, FSC	FEW
Lewis' woodpecker	*Melanerpes lewis*	FSC	VFR,BO/FP,PP
loggerhead shrike	*Lanius ludovicianus*	CS, FSC	AG,C
long-billed curlew	*Numenius americanus*	CS, FSC	FEW,AG,C,
long-eared owl	*Asio otus*	CS	VFR,AG,BO/FP
Merlin	*Falco columbarius*	CS	FEW,AG,L,VFR
mountain plover	*Charadrius montanus*	FPT	AG,C
northern goshawk	*Accipiter gentilis*	CS, FSC, F	MHC
northern harrier	*Circus cyaneus*	CS	AG,C,FEW
olive-sided flycatcher	*Contopus borealis*	FSC	MHC
Osprey	*Pandion haliaetus*	CS	L,R
prairie falcon	*Falco mexicanus*	CS	AG,C
purple marten	*Progne subis*	CS	VFR,MHC,PP
red-breasted sapsucker	*Sphyrapicus ruber*	FSC	BO/FP,VFR,MHC
sharp-shinned hawk	*Accipiter striatus*	CS	VFR,PP,MHC
short-eared owl	*Asio flammeus*	CS, FSC	FEW,AG,C
Southern bald eagle	*Haliaeetus leucocephalus leucocephalus*	FT, SE	L,R,PP,MHC,VFR
Swainson's hawk	*Buteo swainsoni*	ST	AG,C,VRF

tricolored blackbird	*Agelaius tricolor*	CS, FSC, B	FEW,AG,C
Vaux's swift	*Chaetura vauxi*	CS, FSC	MCH
western burrowing owl	*Athene cunicularia*	CS, FSC, B	AG
western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	SE, FSC	VFR,V/O
white-faced ibis	*Plegadis chihi*	CS, FSC	FEW,C
white-tailed kite	*Elanus caeruleus*	FSC	AG,C
willow flycatcher	*Empidonax traillii brewsteri*	SE,F	VFR
yellow warbler	*Dendroica petechia*	CS	VFR
yellow-breasted chat	*Icteria virens*	CS	VFR
AMPHIBIANS			
California red-legged frog	*Rana aurora draytonii*	FT, CS	FEW
California tiger salamander	*Ambystoma californiense*	CS, FC	AG
foothill yellow-legged frog	*Rana boylii*	CS, FSC, F,B	VFR,PP,MCH
western spadefoot toad	*Scaphiopus hammondii*	CS, FSC, B	AG,VFR,O/V
REPTILES			
California horned lizard	*Phrynosoma coronatum frontale*	CS, FSC, B	AG,VFR,
giant garter snake	*Thamnophis gigas*	FT, ST	FEW
southwestern pond turtle	*Clemmys marmorata pallida*	CS, FSC, F, B	R,L
MAMMALS			
American badger	*Taxidea taxus*	CS	AG, BO/FP
fringed myotis bat	*Myotis thysanodes*	CS, FSC, B	VFR
greater western mastiff bat	*Eumops perotis californicus*	FSC	All terrestrial
long-eared myotis bat	*Myotis evotis*	CS, FSC, B	All terrestrial
long-legged myotis bat	*Myotis volans*	CS, FSC	MC,MHC
Pacific fisher	*Martes pennanti pacifica*	FSC, B, F	MHC,
Pacific western big-eared bat	*Corynorhinus townsendii pallescens*	FSC, B, F	All terrestrial
pallid bat	*Antrozous pallidus*	CS, F, B	All terrestrial
small-footed myotis bat	*Myotis ciliolabrun*	CS, FSC, B	All terrestrial
Towndsend's big-eared bat	*Corynorhinus townsendii townsendii*	CS, FSC, F, B	All terrestrial
Yuma myotis bat	*Myotis yumanesis*	CS, FSC, B	R,L,VFR
INVERTEBRATES			
Amphibious caddisfly	*Desmona bethula*	FSC	R
California linderiella	*Linderiella occidentalis*	FSC	AG
Conservancy fairy shrimp	*Branchinecta conservatio*	FE	AG
Sacramento Valley tiger beetle	*Cicindela hirticollis abrupta*	FSC	
Valley elderberry longhorn beetle	*Desmocerus californicus dimorhus*	FT	VFR
Vernal pool fairy shrimp	*Branchinecta lynchi*	FT	AG
Vernal pool tadpole shrimp	*Lepidurus packardi*	FE	AG

STATUS KEY	
FE	federal endangered
FT	federal threatened
FSC	federal species of concern (includes federal Migratory Nongame Birds of Management Concern)
SE	state endangered
ST	state threatened
CS	state species of special concern
B	BLM sensitive
F	USFS sensitive

HABITAT KEY	
C=cropland	AG=annual grassland
VFR=valley/foothill riparian	MH/C=montane hardwood/conifer
MC=mixed chaparral	R=riverine
FEW= freshwater emergent wetland	U=urban/residential
L=lacustrine	BO/FP=blue oak/foothill pine
O/V=orchard/vineyard	PP=ponderosa pine

magpie, quail, and woodpeckers were used as ornamentation. Porcupine tails were used as hairbrushes. Grizzly bear hides were used for ritual dances. The Maidu tribe still conducts a two-day gathering near Janesville each spring where the Maidu Bear Dance is performed.

4.8 CULTURAL RESOURCES

4.8.1 Cultural History of the Project Area

4.8.1.1 Prehistoric Overview

Human occupation of the northern Sacramento Valley may span 10,000 years or more; however, reliable evidence of the presence of early inhabitants is lacking. Much of the evidence for early human presence in the area may be deeply buried under alluvium (Moratto 1984), or may have been destroyed by dredge mining.

Much of the knowledge of prehistory of the area is due to the intensive archaeological investigations that were conducted along the Feather River in association with construction of Oroville Dam (Ritter 1968, 1970). The cultural sequence of this area has been divided into four phases: Mesilla, Bidwell, Sweetwater, and Oroville. Some artifacts, including choppers, hammer stones, scrapers, and spire-lopped Olivella beads, appear to remain unchanged throughout the four phases; thus, the phases are marked by variances in their artifacts (Moratto 1984).

The Mesilla Phase (1000 BC to AD 1) represents the earliest period of occupation of the Oroville area. Influences from both the Sierra Nevada and Sacramento Valley cultures are evident in the assemblage for this phase. Characteristic artifacts for the Mesilla Phase include steatite vessels, wooden mortars and pestles, manos and milling stones, bone spatulae, Haliotis and Olivella beads, obsidian pins, and charmstones. Projectile point types include large leaf-shaped, stemmed, and side-notched points. Materials used include heavy basalt, slate, and chert.

The Bidwell Phase (AD 1 to 800) appears to have been a more sedentary lifestyle with permanent villages and smaller hunting and fishing groups. Characteristic artifacts for this phase include mortars and pestles, large basalt drills, bone awls, grooved and notched sinker stones for fishing nets, and steatite vessels. Projectile points are predominantly basalt and include large corner-notched and side-notched, wide stemmed, small corner-notched, and leaf-shaped points. According to Kowta (1988), the Bidwell Phase is a continuation of the Mesilla Phase and shows intensified use of the environment and increased adoption of Central Valley artifacts and traits.

The Sweetwater Phase (AD 800 to 1500), representing the late period in the Oroville area, is marked by an increase in acorn use, refinement of material culture, an increase in luxury or status items, and population growth (Kowta 1988). The artifact assemblage for this phase includes split-punched and rectangular Olivella beads, freshwater clam shell spoons, steatite cups, platters, bowls, smoking pipes, bone pins, fish gorges, and awls. Intensification of acorn use is reflected in the abundance of slab mortars and flat-ended pestles (Nilsson et al. 1995). Projectile point types during this phase, including the Eastgate, Rose Spring, and Gunther-Barbed, reflect the emergence of the bow and arrow (Nilsson et al. 1995).

The Oroville Phase (AD 1500 to 1850) represents the protohistoric and ethnographically documented Maidu. This phase is characterized by an increase in population growth and a diversity of artifact forms. Oroville Phase artifact markers include clamshell disc-beads, thick-lipped Olivella beads, Haliotis ornaments, incised bird bone tubes, gorge hooks, and gaming bones. While the use of portable and bedrock mortars increase during this period, manos and metates continue to be used. Steatite artifacts include cooking slabs, arrowshaft straighteners, and tubular pipes with basalt flanges. Flake stone tools include small side-notched, corner-notched, and triangular projectile points, small scrapers, and drills (Nilsson et al. 1995).

4.8.1.2 Ethnographic Background

The project area is located in the ethnographic territory of the Konkow Indians, also known as the Northwestern Maidu (Riddell 1978). The Northwestern Maidu are one of three major divisions of related groups identified as Maidu, the other two being the Mountain Maidu to the northeast and the Nisenan to the south. Konkow was a language spoken in a number of dialects along the lower reaches of the Feather River Canyon, in the surrounding hills, and in adjacent parts of the Sacramento Valley. The Konkow name is derived from the Anglicization of the native term for "meadowland" (Riddell 1978).

The Konkow were organized in village communities in which a larger, major village was marked by a semi-subterranean assembly and ceremonial lodge. The major villages provided a central ceremonial and political focus for nearby affiliated satellite villages. The chief, generally known for his leadership abilities, wealth, and generosity, may have required selection by the shaman rather than representing a line of descent (Kroeber 1925; Riddell 1978). The satellite villages came together in ceremonial performances as well as other events and activities. Village communities were estimated to have been comprised of from three to five villages, with a population of approximately 200 individuals and a defined territory (Kroeber 1925; Riddell 1978).

Like most California Indian Tribes, the Konkow practiced a mixed gathering, fishing, and hunting economy. Vegetal resources were gathered in an annual cycle in which target plants were procured as they ripened. Families moved to strategic locations to harvest desired foods including various greens, roots, seeds, nuts, and berries. Pine nuts from both sugar and foothill pines were valued, but the most important vegetal food was the acorn from various species of oak. Acorns were gathered, dried, and stored in granaries for winter use.

The Feather River offered a wealth of fish resources, especially the seasonal anadromous fish (salmon) runs, which provided an abundant source of food. Salmon was dried and then pounded into a powder for storage (Riddell 1978). Hunting too provided important sources of food. Game animals include deer, elk, rabbit, squirrel, quail, pigeon, duck, and geese. Deer were often taken in large drives in which men cooperated to herd the deer over a cliff or into an area where concealed hunters could shoot them (Dixon 1905; Kroeber 1925; Riddell 1978).

The Konkow practiced elaborate ceremonial observances including activities associated with a secret society, the Kuksu cult, mourning rituals for the dead, and shamanism. The secret society was of great importance as it was responsible for the annual cycle of ceremonies and dances that were essential for the well being of the community. The dance or ceremonial season typically began in October and lasted through April or May, during which time five or six ceremonies were performed (Dixon 1905). The ceremonies focused on communicating with the supernatural world, giving thanks to the spirits, and asking for continued blessings from them. Performance of these ceremonies during the proper time and in the proper manner was important to ensure the well-being of the community.

Upon the death of a community member, the body was washed, dressed in the finest clothes, and adorned with beads and shell ornaments. Burial took place in the community cemetery, which was usually within a half mile of the village. Belongings of the deceased were buried with the body or burned, and the widow or widower cut his or her hair short and covered his or her face with a layer of pitch and charcoal (Dixon 1905). Each fall the community held a mourning or burning ceremony, or "cry," for those who had died during the past year. This observance was held at or near the cemetery. Each family brought goods fixed on poles, and the ceremony climaxed with the burning of these offerings. Afterwards, a feast was held in the assembly house so the mourners could celebrate and rejoin the daily life of the society (Riddell 1978).

During the early 1800s, new and deadly diseases were introduced to the Maidu people by early European explorers and traders. At least one devastating malaria epidemic in 1833 is believed to have been brought by trappers to the Central Valley Indians, including the Maidu (Cook 1955). This epidemic has been estimated to have decimated approximately 75 percent of the native population. However, it was the Gold Rush of 1849 that caused the most destruction to Maidu society and culture. Thousands of miners swarmed into the foothills, pushing native groups out of their way. Many Indians died at the hands of the miners and from the renewed introduction of disease.

Conflicts continued between the Indian people and the settlers, and in 1863 a number of Konkow were forcibly marched from their homes in the foothills to the Round Valley Reservation in the North Coast Ranges. This event, known as the "Death March," is well remembered by the Maidu and the Konkow. Many Indian people remained in or returned to Maidu/Konkow territory and found ways to survive. Finally, in the 1920s, the federal government established small rancherias (reservations) for a number of Maidu/Konkow groups including Mooretown and Enterprise Rancherias.

The first documented expedition into the Oroville area occurred in 1808, when a party of Spanish soldiers led by Gabriel Moraga traveled through the region while searching for a mission site. Subsequent expeditions were made by Spanish Captain Louis A. Arguello in 1820, and by American trapper Jedediah S. Smith in 1827-1828 (McGie 1982).

The settlement of Oroville by Europeans began when gold was discovered at the site in 1849. The camp that arose and developed at the site of Oroville was initially named Orphir City, after the fabled gold mines in southern Arabia (McGie 1982). In 1854, after officials discovered that a town in Placer County had already been named Orphir, the settlement changed its name to Oroville (Gudde 1969). By 1856 Oroville had grown into an incorporated city of more than 4,000 people, making it the fifth largest town in California (McGie 1982). During the 1850s, Oroville was a typical gold camp or Gold Rush boomtown, complete with a loosely constructed main street surrounded by miners' cabins and tents. By the end of the 1850s, however, the surface gold diggings had largely been exhausted, and Oroville went into a period of economic and demographic decline.

With the decline of placer mining, Oroville's economy shifted increasingly toward agriculture. Grain growing in the 1860s and citrus and olive production in the late 19th century became especially important as miners began settling down with their families to farm rather than to prospect for gold for a living. With the passage of the Fence Law by the California State legislature in the 1860s, wheat production in the Oroville area increased dramatically. Contributing to this increase was the shortage of wheat in the eastern states caused by disruptions associated with the Civil War. Butte County, subsequently, became the primary wheat producer in California until 1870 (McGie 1982). With the establishment of a ferry crossing at Oroville in 1852, the construction of a flour mill on Montgomery Street in 1858, and the completion of a railroad line from Marysville to Oroville in 1864, Oroville rose as a significant trading point for grain growers in the area.

By the end of the 1880s, wheat production had begun to decline and farmers were allocating more acreage to crops such as citrus and olives. Old mining ditches were converted into irrigation canals, and the development of new irrigation projects around Oroville encouraged the diversification of crops. A former state senator and circuit judge, Charles Fayette Lott, started the first commercial planting of orange trees in the Oroville area. Lott was a citizen of Oroville, residing in a house on Montgomery Street. Later, he became the first president of the Oroville Citrus Association (Green 1996). By the late 1880s, citrus groves occurred in increasing numbers throughout Butte County.

The olive industry in the Oroville area had its beginnings in the late 1880s. The first commercial planting of olive trees in the Oroville area was on a parcel near the Feather River in 1887 (Mansfield 1918). Eventually, a successful olive oil mill and olive packing industry developed. The largest and most successful olive processing operation is the Ehmann Olive Company. Both the olive and citrus industries remained important to Oroville's economy through the 1950s.

During the 1890s, mining again became an important industry in the area with the development of river dredging. After it began, gold dredging along the Feather River transformed Oroville into the "mother dredging field of the state" (Mansfield 1918:328). From 1898 to 1916, Butte County was one of the most important gold-producing counties in California (McGie 1982). After 1916, the industry declined rapidly because the supply of gold in the area was exhausted. By 1930, dredging companies no longer found it possible to continue operations and moved out of the Oroville area.

The huge tailings of rocks and boulders remaining from the dredging operations were eventually put to use in the construction of Oroville Dam during the early 1960s (Talbitzer 1987). The completion of the dam in 1968 has been important to the Oroville region because the dam provides water for agriculture, hydroelectric power, and recreation purposes.

4.8.2 Cultural Resource Sensitivity of the Lake Oroville Area

The project area upstream of the dam is situated in the northern Sierra Nevada foothills between 300 feet in elevation at the toe of the dam and spillway and 1,400 feet in the upper reaches of the Middle Fork Feather River. The terrain typically consists of broad ridges that separate the deep, steep-sided rocky canyons of the Feather River and its tributaries.

The archaeological record provides evidence of the earliest occupation in the region dating to at least several thousand years ago, with a few sites thought to represent initial settlement by Hokan language speakers. These people were seasonally mobile and relied on stone milling implements to process hard seeds, their food staple subsistence base. Subsequent archaeological periods are represented by more numerous sites that document the intrusion of Proto-Penutian speakers who displaced the Hokan peoples and developed a local cultural sequence that continued through to the ethnographic period of the Konkow (Olsen and Riddell 1963). All of the prehistoric archaeological periods are represented at Lake Oroville, including the ethnographic settlement pattern of the village community and the period of historic contact with Euro-American settlers (Kroeber 1925; Riddell 1978).

Prehistoric settlements were generally situated on the top of ridges, on canyon side mid-slope flats, and on the crest of knolls. Site types include lithic scatters, quarries and toolstone source locales, caves and rockshelters, seasonal camps, large village settlements, and burial grounds. Associated elements include milling features, structural remains, and rock art. Konkow ethnographic and historic period sites and places are also known.

The Lake Oroville area also has a significant historic record. With the discovery of gold in 1849, thousands of gold seekers poured into the hills around Oroville. Many foothill mining towns were established that were short-lived and later deserted when the gold was depleted and the effort moved to river dredging at lower elevations. Remains of several of these towns were inundated by the reservoir. Once the Gold Rush was over, the lumber industry became dominant and was a major employer until recent years.

Another aspect of the historic saga of the Feather River country involved the search for a year-round trans-Sierra railroad route. Many attempts were made between the 1860-1880s, but they all failed because the Middle Fork Feather River was found impassable in the vicinity of Bald Rock Canyon. By the turn of the century, a successful route was finally found along the North Fork Feather River (DPR 1973a).

Limestone mining/processing was a relatively small industry compared to the gold mining operations; however, it was a significant component of the local economy around the turn of the century. Quicklime from the Lime Saddle kilns on the West Fork Feather River was used in the construction of the early buildings in Chico and other communities in the north valley region.

The original impetus for the local agricultural industries was to support the hordes of gold seekers who were working and settling in the area. Especially important were livestock grazing and tree crops such as olives, figs, and citrus.

Although, mining, transportation, forestry, homesteading, agriculture, and associated water development are all represented archaeologically, they are not well documented and are significantly under-represented in the historic archaeological record. Evidence of these activities at Lake Oroville includes hydraulically mined landscapes and lime kilns, railroad grades and ferry landings, skid trails and loading ramps, wagon roads and gully dumps, leveled fields and fence lines, flumes, and diversion structures. Scant attention was paid to these historic period archaeological features and sites in the 1960s when the most extensive surveys were conducted.

4.8.2.1 Previous Studies

Virtually all of the archaeological work at Lake Oroville, both survey and excavation, has been done in connection with construction of the dam and reservoir or with recreation development as a unit of the State Park system. The first project was a survey carried out by the University of California, Berkeley in 1952, for the National Park Service, acting for Region 2, Bureau of Reclamation. A crew of two student archaeologists, under the direction of Adan Treganza from the University of California Archaeological Survey Office, spent two months recording the first sites in seven northern and central California watersheds under consideration for reservoir projects (Treganza 1953). Of the 30 sites they recorded at the Oroville Project, 17 were within the pool zone below 820 feet elevation; of the 13 sites above the pool, 12 were located on the high ridges separating the South Fork from Middle Fork Feather River. Many of these sites consisted solely of bedrock mortars. Treganza concluded that the only site that appeared to contain enough depth and surface indications to warrant further investigation was located 1,000 feet above the maximum high water level (elevation 820 feet) of the proposed reservoir. Since the site would not be destroyed, he recommended that no additional work in the project area would be justified.

The FERC Order Issuing License (Major) for Project No. 2100 (Oroville), dated December 14, 1956, contained two articles pertinent to cultural resources. Article 38 required complete clearing of all lands in the bottom and margins of Lake Oroville (later renamed Lake Oroville) and clearing of all brush and trees between elevation 640 and 900 feet. Article 39, stated that “The licensee shall notify the University of California of the proposed construction of the project and the extent of the reservoir area so that that University may negotiate with the licensee for the purpose of undertaking archaeological surveys and excavations, if considered desirable, prior to flooding of the reservoir area."

Given the recommendations in Treganza's report, prepared four years earlier under the guidance of R.F. Heizer, Director of the University of California Archaeological Survey, and given that Heizer usually discouraged university involvement in "public archaeology," it is not surprising that the university did not consider the project desirable enough to "negotiate with the licensee." This situation was to some extent remedied by actions of the State Legislature and the DWR after passage of the California Water Resources Development System Bond Act ensured the immediate construction of the Oroville Project. It was recognized that the proposed project would flood Curry-Bidwell Bar State Park and "inundate various historical objects now a part of the interpretive program" (Division of Beaches and Parks 1962).

Assembly Act No. 1045 of 1960, added Section 234 to the State Water Code, authorizing DWR to engage an archaeologist "to conduct archaeological site surveys in areas of development and construction." This was accomplished through an Interagency Agreement with the Division of Beaches and Parks (now the Department of Parks and Recreation). Francis A. Riddell, who was then Director of the State Indian Museum and coincidentally had been Heizer's student and an employee of the University Archaeological Survey, was reassigned to conduct the surveys and had the task of completing "preliminary field work at more than a dozen planned reservoir sites by the end of June 1960" (DWR 1960), a 6-month project.

In further recognition that "the problems created by this inundation are many and varied and of major consequence" and "recognizing the importance attached to some of these problems, especially those dealing with historical significance, the 1961 Session of the California Legislature enacted Assembly Concurrent Resolution No. 86" (Division of Beaches and Parks 1962). This resolution "requested the Division of Beaches and Parks to cause investigations, studies and surveys to be made, and present recommendations on the disposition of the historical objects at Curry-Bidwell Bar State Park" (Division of Beaches and Parks 1962). The basis for the enactment of this resolution was the Davis-Dolwig Act of 1961, which states in part that the Division is directed to design, construct, operate, and maintain public recreation facilities at SWP projects. Thus, the initial planning and construction of the SWP and enacting legislation established the precedent that led to the creation of the State Archaeologist positions in California civil service.

Riddell started the Oroville survey work early in 1960 and continued with surveys and excavations through the mid-1960s. In August 1963, he was able to hire an Assistant State Archaeologist, William Olsen, who had replaced him as Director of the State Indian Museum, to help with the DWR reservoir projects (Riddell 1960-1964). In addition to doing much of the work themselves, they were able to hire temporary archaeological employees and to arrange for some of the work to be carried out under contract to the Division of Beaches and Parks. Riddell and Olsen interested other archaeologists and students, primarily from the Sacramento area, to volunteer to assist with the survey and "salvage" work at Lake Oroville. They coordinated and provided guidance to these efforts that were generally limited to the land to be inundated, railroad and road relocation corridors, haul roads, and DWR facilities (e.g., dam, spillway, canal construction zones). Accessibility by road often determined which areas were examined (William Olsen, personal communication).

Two of the three reports that have been published on Lake Oroville archaeology were based on the construction-related surveys and excavations of the early 1960s. The first was related to the relocation of the Western Pacific Railroad grade around the western perimeter of the reservoir (Olsen and Riddell 1963). Although the four sites (BUT-98, -103, -105, and -131) studied were located four to five miles west of the current project boundary, their research is germane to the current study area. They used their excavation data to develop a tentative cultural sequence for the Oroville region that spanned the period from 500 BC to AD 1850. They compared the Oroville chronology, naming the Mesilla, an unnamed complex, Sweetwater, and Oroville archaeological complexes, with comparable chronological frameworks proposed for the valley, foothills, and Sierra. They suggested that a number of ethnographic practices were derived from prehistoric antecedents and found evidence that the Oroville sites reflected prehistoric influences from the higher Sierra and Great Basin as well as from the Sacramento Valley.

The second published report was based on excavations conducted in 1961 at three village sites with a total of 15 housepits that were going to be destroyed by construction of the spillway (Jewell 1964). The sites, which dated to the late prehistoric and early historic periods, were probably winter villages whose inhabitants were primarily dependent on the pine nut and acorn harvests and the fall salmon run in the Feather River. The study was important for the detailed information it provided about house remains and village configuration.

The ongoing surveys carried out by Riddell, later joined by Olsen, during the early 1960s were supplemented during the summer of 1963 by the team of John Duncan, an anthropology graduate student at Sacramento State College and Adrian Smith, a local Maidu resident. The Duncan-Smith survey (1963) and the Ritter-Chartkoff survey that followed in 1965 were responsible for recording most of the sites known prior to inundation.

The next major excavation project was conducted during the summer of 1964 by students from American River Junior College working under the direction of Charles Gebhardt (Gebhardt 1964; Olsen 1964). The team worked at several sites with housepits near Bidwell Bar. They recovered both traditional artifacts and historic period trade goods such as buttons, cartridges, glass, and nails. Occupation may have been as late as the 1870-1880s, and some of the sites were known by name to local Maidu informants.

The most extensive surveys were done during the summer of 1965, led by Eric Ritter and Joseph Chartkoff, anthropology graduate students from UC, Davis and UCLA, respectively. In total, 153 sites were recorded, including 41 villages with housepits, 57 midden sites without structural remains, and 55 bedrock mortar sites (Chartkoff and Ritter 1966). This work provided new information about village size, number and size of houses, and the location and configuration of bedrock mortars.

Ritter returned to Oroville in the summer of 1966 and carried out the most extensive excavations done to date at BUT-84 (Tie Wiah), a large village site tested in 1964 by Gebhardt and his students. With the data from the study of a huge artifact inventory with over 1,500 diagnostic projectile points, and the analysis of burials and accompaniments, structural remains, and other archaeological features, as well as through comparison with other sites in the region, Ritter was able to modify and elaborate on the synthesis and temporal framework presented earlier by Olsen and Riddell (1963). Ritter also defined their unnamed period between the earliest Mesilla Complex and the Sweetwater Complex, calling it the Bidwell Complex, dating to the AD 1 to AD 800 period. Another field season was held at the site during the following summer, supervised by Roland Gage, a graduate student at Sacramento State College. Ritter used the BUT-84 work from both seasons for his Master’s thesis (Ritter 1968) and synthesized his findings in the context of a larger regional framework in the third publication dealing with Lake Oroville prehistory (Ritter 1970). Harvey Crew (1978) some years later used a new lithic reduction process model to reanalyze a sample of the flaked stone assemblage from the site.

The second Master's thesis on Lake Oroville archaeology was based on fieldwork carried out by Richard Markley in 1975, at five sites that were going to be affected by construction activities (Markley 1978). Of the two sites he investigated in the current study area, BUT-21 was going to be damaged by work on the road through the Craig Saddle area, and BUT-521, located in Loafer Creek Campground, was going to be disturbed by construction in the park employee housing area. The latter site was a permanent housepit village with an occupational history that originated during Mesilla Complex times and extended to the early 1800s. The housepits, similar to those described earlier by Jewell (1964) and Ritter (1968), represented semi-subterranean bark-covered structures that corresponded to the ethnographically recorded examples of the Maidu hubo. Site BUT-21 had a comparable time depth but was thought to be a seasonally occupied site. The artifact assemblage, which included steatite vessels and proximity of the site to cupule petroglyphs and numerous bedrock mortars, suggested it may have been important as a ceremonial locale. The artifact assemblages at both sites were generally similar to those described at other sites in the locality and supported Olsen and Riddell's and Ritter's chronological cultural sequences.

In 1976-1977, DPR carried out surveys, site testing, and historic research connected with recreation development at Lime Saddle Recreation Area in the upper reach of the West Branch Feather River (Furnis and Young 1976; Sampson and McAleer 1977). Two prehistoric sites had been recorded there during the reservoir surveys of the 1960s (Palmer 1962; Ritter and Smith 1965) and the DPR surveys of 1976-1977 added an additional three prehistoric and three historic sites. Two of the historic sites were particularly noteworthy, limestone quarries with associated kilns and processing areas. The industry was developed by Augustus Parrish, a notable local resident who operated the enterprise between 1892-1904. Detailed archival and oral history research on ownership and operation of the Parrish quicklime business was carried out by DPR in support of the 1976-1977 archaeology program at Lime Saddle (McAleer 1977).

Three subsequent surveys (Woodward 1984; Hood 1988; Jensen and Associates 1990) of a small parcel contiguous with the west edge of the Lime Saddle Recreation Area added a bedrock mortar site, three water ditches, and a dry-laid stone wall to the inventory. Between 1997-1999, DWR (Orlins 1997; Hunter and Orlins 2000) carried out intensive surveys of the Lime Saddle area in preparation for the design of a developed campground. Five of the previously recorded sites were re-recorded and 15 new sites, 10 historic and five prehistoric, were added to the inventory. The historic sites were mostly mining prospect pits (donkey holes), and the prehistoric sites consisted of two milling stations, two possible housepit sites, and a lithic scatter that may have some midden deposit.

In summary, the Lime Saddle Recreation Area, covering about 200 acres, has been subject to complete and intensive survey and is likely the most thoroughly surveyed locality at Lake Oroville. Several of the sites found in the 1960s are now inundated, including one of the limestone quarry/kiln sites; however, a total of 20 sites, eight prehistoric and 12 historic, are still accessible. It is not known if the density of one site per ten acres is representative of the Lake Oroville study area or if it is skewed by the number of donkey holes.

In the 1990s, DPR conducted several systematic surveys of the Craig Saddle Recreation Area to address the problem of continuing site looting and vandalism. These surveys that have thus far covered 375 acres or approximately half of the area, have resulted in Craig Saddle being the next most completely inventoried locality at Lake Oroville. Treganza (1953) recorded several sites during his initial survey that have avoided inundation and several more sites were added during the DPR surveys of the 1960s (Olsen 1963; Duncan and Smith 1963; Ritter 1965-1966), but it was not until 1991 that the first systematic survey was conducted. Rivers (1991) surveyed 60 acres and recorded five new prehistoric sites, followed by Hines (1996) who surveyed 200 acres and recorded 9 new prehistoric and two new historic sites. The most recent survey at Craig Saddle (Steidl et al. 1999) covered 115 acres and resulted in the identification of 13 new sites, six prehistoric, five historic, and two multi-component sites.

Thus, in addition to the DPR reservoir construction surveys of the 1960s, a total of 375 acres has been systematically surveyed in the Craig Area, yielding 40 sites. Furthermore, two cemeteries in the Craig area, the Martin Cemetery and the Spencer/Sweetman Cemetery, may have significant time depth and are still in use by the local Indian community. Interestingly, although the sites at Craig Saddle primarily represent Native

American occupation, the site density approximates that of Lime Saddle, where the density of one site per ten acres was more reflective of historic period activities.

Rock art sites have not been recorded in the lower Feather River study area but have been documented and analyzed in the Lake Oroville study area (Ritter and Parkman 1992). Eleven sites have been recorded with petroglyphs; pictographs are not known. These features were typically associated with village sites and with bedrock mortar features near major streams or rivers. Eight of the petroglyph locales were situated in canyons and three were on broad ridges. Seven are pecked, incised, or ground in granodiorite outcrops and four are on greenstone outcrops.

The glyphs are characteristic Sierran abstract and geometric forms: cupules and grooves, diamonds and parallelograms, concentric circles, reticulates, sunbursts, dots, and curved wavy lines. Two of the sites also have anthropomorphic forms. There is little direct ethnographic information about Northern California rock art; scholars hypothesize they relate to multiple aspects of cultural expression including human health and fertility, sustenance and food production, and territorial markers and social identity. They are also thought to have played an important role in the spiritual and ceremonial life of the community related to the mythical world, healing practices, and shamanistic vision quests (Ritter and Parkman 1992).

4.8.2.2 Recognized Sites

Several historic properties associated with Lake Oroville have qualified for local, state, and federal recognition. The 1961 session of the State Legislature that enacted Assembly Concurrent Resolution No. 86 requested the Division of Beaches and Parks "to cause investigations, studies and surveys to be made, and present recommendations on the disposition of the historical objects at Curry-Bidwell Bar State Park" (California Assembly 1961). This State Park was located at the ruins of the Gold Rush mining town of Bidwell Bar, the county seat in 1850 and again in 1853, whence it was moved to Oroville. With the planned construction of Oroville Dam, the park would be completely inundated. An outpouring of local concern found its way to the State Legislature, regarding the potential destruction of the Bidwell Bar Bridge, Old Toll House, and Mother Orange Tree, the "historical objects" referred to in the Assembly Resolution.

In 1854, the Bidwell Bridge Company was organized and given a license to build a suspension toll bridge to replace the unreliable ferry crossing. A contract was awarded to

Jones and Murray Contractors, Sacramento, for construction of the bridge. It was purchased from the Troy Iron Works, New York, shipped around Cape Horn by sailing vessel, and freighted from San Francisco to Bidwell Bar by ox team (Boyle 1950).

The bridge spanned the South Fork Feather River, was 240 feet long, and built at a cost of some $35,000 (Engineering News-Record 1946). The roadway was 18 feet wide and the abutments 12 feet high (Division of Beaches and Parks 1962). It was thought that melted sheets of lead foil, shipped from China, were used to embed the cables in the rock piers (Boyle 1950). Another report indicated eyebolts were anchored in place with melted sulphur that expanded on cooling (Engineering-News-Record 1946).

The bridge opened in early 1856 but despite the heavy traffic did not make enough money to be a profitable business. Butte County bought it in 1883 with rights-of-way, appurtenances, and franchises for $8,000. It was part of the State Highway System between 1909 and 1938, when it was again turned over to Butte County until 1948, when the Division of Beaches and Parks assumed ownership. Because of its deteriorating condition, the Division of Highways closed it to vehicular traffic in 1956. To avoid being submerged, it was dismantled and reconstructed in Bidwell Canyon, a mile and a half downstream from its original location (Division of Beaches and Parks 1962).

The bridge, as the first suspension bridge west of the Mississippi River and the oldest in California, has been documented to federal standards as an Historic American Engineering Record (HAER) property (DPR 1999). State recognition was given to the bridge, accompanying tollhouse, and Mother Orange Tree in 1939, when they were registered as State Historic Landmark No. 314 (Office of Historic Preservation 2000a).

The tollhouse stood on the south side of the bridge and had rock-rubble wall construction with wood floors. The first bridge keeper to use the tollhouse was Howard Burt who was followed in 1859 by Isaac Ketchum, both of whom had a role in planting the Mother Orange Tree. The tollhouse was the only suitable building remaining in the town ruins of Bidwell Bar available for the Curry-Bidwell Bar State Park headquarters and ranger residence. Interior modifications in the 1940s-1950s adapted it for that purpose (Welts n.d.).

The “Mother Orange Tree,” thought to be the oldest orange tree in the state, was brought to Bidwell Bar from Sacramento in 1856 by Judge Joseph Lewis, the principal owner of the suspension bridge. It was planted by Howard Burt on the north side of the road at the west end of the bridge. Ike Ketchum transplanted it to the south side of the road in 1862 when it was threatened by floodwaters. It became famous as the first orange tree, a pioneer in a wild and rugged country, responsible for starting a new industry in a new area hundreds of miles north of the known citrus region. As the antecedent of many northern California orange trees, its seeds were widely distributed throughout the region (Webber 1927).

The tree and bridge were locally recognized during the Orange and Olive Exposition at Oroville, November 27, 1926, on the 70th anniversary of its planting. A monument was installed dedicated to the pioneers of California by the County Board of Supervisors, Gold of Ophir Parlor No. 190 Native Daughters of the Golden West, and Argonaut Parlor No. 8 Native Sons of the Golden West (Webber 1927).

In 1964, the tollhouse was dismantled and reconstructed adjacent to the reconstructed bridge to save it from inundation by Lake Oroville. The Mother Orange Tree was moved at the same time and replanted at 400 Glen Drive, Oroville, near the DWR Oroville Field Division Headquarters Office.

The ruins of the Gold Rush town of Bidwell's Bar, later Bidwell Bar, were recognized in 1939 as State Historic Landmark No. 330 (Office of Historic Preservation 2000a). The town was named after John Bidwell, who arrived in California in 1841 with the first settlers to cross the Sierras. He discovered gold at Hamilton and Bidwell Bar in 1848 and established a mining camp at the bar with Indian and Anglo helpers. He later founded and laid out the town of Chico and offered free homesites to attract new settlers there (Welts n.d.).

With a population estimated at some 6,000 persons, Bidwell Bar was an important community during the height of the Gold Rush. It was the county seat for two brief periods, had 1 of three public schools in the county in 1853, had the first newspaper in the county, the Butte Record, and was the locale of the first fluming of a river. Among other businesses, there were four express companies, many hotels and rooming houses, a theater, a post office, and, typical of most Gold Rush towns, a multitude of saloons and gambling halls (Division of Beaches and Parks 1962). The townsite is now 600 feet under Lake Oroville.

No historic properties at Lake Oroville have been determined eligible or are listed on the National Register of Historic Places (Office of Historic Preservation 2000a).

4.8.2.3 Site Inventory

The attempts to estimate the number of sites at Lake Oroville over the past five decades is illustrative of the evolution of archaeological survey standards. The initial survey by the University of California in 1952 resulted in the recording of 30 sites (Treganza 1953). The survey by Chartkoff and Ritter (1966) during the summer of 1965 prior to the filling of the reservoir led to the identification of 153 new sites. The Assistant State Archaeologist at the time estimated that the archaeological program carried out for DWR by DPR between 1960-1967 resulted in “some 225 sites” recorded in the project area (Olsen 1970). His estimate included the area downstream of the dam but did not include recreation areas, none of which had yet been surveyed.

The Resource Inventory (1973a) prepared by DPR in conjunction with the Lake Oroville State Recreation Area Resource Management Plan and General Development Plan (1973b) relied on a later tally, indicating that at least 145 sites recorded during the DPR archaeological program were covered by Lake Oroville (Olsen 1972). By that time, some survey had been done at the recreation areas and Olsen noted that 27 definite sites and six possible sites had been identified within five of the 10 designated recreation areas. Another 12 sites had also been located “within the vicinity of Lake Oroville’s shore” (DPR 1973).

The DPR estimates that followed by Kalenik (1981) and Swiden (1986) had problems related to the inclusion of sites outside the project area boundaries, difficulty in mapping site locations in a rugged landscape, and a different emphasis on the sites selected for re-examination (Hines 1987).

The most accurate estimates of total site numbers were generated by DPR archaeologists Barter (1987) and Hines (1987). Their work was based on review of the site location base maps at the California Historical Resources Information System, Northeast Information Center, at California State University, Chico. Barter (1987) produced a site list that showed 192 sites located in Lake Oroville State Recreation Area. Hines (1987) undertook a more detailed analysis. He judged that at the time of his study “142 of the original 206 sites were below the waterline all or part of the year.” The breakdown in his Table 2 indicated that 69 sites were submerged, 78 sites were situated in the fluctuation zone between elevation 640-900 feet, and 49 sites were above the reservoir high pool elevation. This yields a total of 196 sites, with 127 sites seasonally exposed during low pool elevations or completely above the inundation zone.

During his field check, Hines determined that site vandalism was a major problem, in fact a greater problem than at any other unit of the State Park System. Of the 31 sites he visited, five “were being willfully destroyed.” He also noted that 11 other sites had been completely or partially destroyed during construction of the dam and appurtenances and recreation facilities (Hines 1987).

Our estimate of the number of sites at Lake Oroville is entirely based on existing records that combine Hines’ (1987) estimate with the results of surveys conducted since that date. The recent DWR surveys at Lime Saddle Recreation Area produced 15 new sites (Hunter and Orlins 2000), and the DPR surveys at Craig Saddle yielded seven new sites in 1991 (Rivers), 11 new sites in 1996 (Hines), and 13 new sites in 1999 (Steidl et al.). If the total of 46 new sites is added to Hines’ estimate of 127 sites, we get a revised total of 173 sites that are now completely or partially accessible.

4.8.2.4 Archaeological Collections and Human Remains

The archaeological collections from the DPR excavations in the early 1960s are curated at the DPR Archaeological Laboratory, West Sacramento. The collections from at least 71 sites, listed under 47 accession numbers, are stored in some three dozen storage drawers. The collections range from 1 artifact to many hundreds from a single site. Many of the collections do not have catalogues and a number of provenience problems need to be resolved; however, DPR has recently initiated a project to address these issues.

The archaeological collections with human remains and associated artifacts are housed by DPR in a special curation facility in West Sacramento. The collections are from six sites excavated at the Oroville Project in the early 1960s; however, only two of the collections are from sites within the boundary of the current study area. Five of the collections are listed under state ownership and 1 collection is under private ownership, although curated by the state. None of the collections from Lake Oroville are listed under federal ownership (Kautz 1988).

The two burial collections from sites in the current study area are from site BUT-84 (Tie-Wiah) (Ritter 1968), located upstream of the dam, and site BUT-157 (Olsen and Riddell

1968), located below the dam. The BUT-84 collection consists of 125 burials, four boxes of unassociated human remains, and 1,273 associated artifacts. The collection from BUT-157 consists of 15 burials and 1,374 associated artifacts (DPR 1992).

Collections recovered during the 1960s work at Oroville, but not from sites in the FERC study area, include BUT-53, BUT-90, BUT-98, and BUT-131. The collection from site BUT-53 (Murphy Site), although from a site located three miles southeast of Gridley on the west bank of the Feather River, was excavated by DPR in 1963 for the Oroville Project. It contains 24 burials and 544 associated artifacts. The excavations at site BUT-90 (Sweetwater Springs Site) yielded 56 burials and 1,480 associated artifacts. This site is just outside of the current study area, north of the Thermalito Diversion Pool and east of Morris Ravine (DPR 1992). The collection is the one noted as being in "private ownership" (Kautz and Taugher 1987).

The other two collections are from excavations related to relocation of the Western Pacific Railroad grade several miles west of the project area (Olsen and Riddell 1963). Site BUT-98 has 1 partial burial with no associated items, and BUT-131 has seven burials and 62 associated artifacts (DPR 1992).

In compliance with the State Public Health and Safety Code, DWR was obliged to relocate 247 graves from Feather River Canyon burial places that were going to be inundated. The burial remains from two historic cemeteries, Bidwell Bar Cemetery and Enterprise Cemetery, and six family plots were disinterred and reburied away from the reservoir area. DWR created Pioneer Cemetery adjacent to Thompson Flat Cemetery, near the west bank of the Feather River just north of Oroville. Surviving family members were given the option of using Pioneer Cemetery or Oroville's Memorial Park. All 103 graves in Enterprise Cemetery and 123 of the graves in Bidwell Bar Cemetery were moved to Pioneer Cemetery. Memorial Park received 42 graves and three were reinterred in other areas. Accompanying headstones, markers, and fences were also moved to Pioneer Cemetery, and DWR provided restoration work for the stones and fences (Warne 1965).

4.8.2.5 Ethnographic Studies

The pioneering ethnographic fieldwork in Maidu and Konkow territory was done by Powers (1877), Merriam (n.d.), and Dixon (1905). This work was subsequently expanded by Kroeber (1925) and his student, Voegelin (1942), both from the University of California, Berkeley. In the early 1960s, State Archaeologist Riddell interviewed Konkow elders in connection with his effort to identify sites that would be inundated by the reservoir (Riddell 1960-62). He incorporated much of this work with that of his predecessors to produce the Konkow and Maidu chapter in the Smithsonian Handbook of the American Indians (Riddell 1978). John Duncan's (1963) Master's thesis on Maidu ethnobotany also resulted from work carried out by DPR during the period of reservoir construction.

The most recent ethnographic studies have also been carried under the aegis of DPR (Barter 1987; Forbes 1989; McCarthy 1998). Barter searched the Hudson Collection, California Indian holdings at the Field Museum of Natural History, Chicago, to identify materials connected with Lake Oroville State Recreation Area. As it happened, in 1903 Dr. John W. Hudson had collected artifacts from Konkow people at Bidwell Bar, Mooretown, Berry Creek, and Brush Creek for the then Field Columbian Museum of Chicago. Barter reproduced Hudson's field notes, photographs, and generated a list of artifacts he collected from the area (Barter 1987).

Forbes' report, jointly funded by the BLM, Department of Forestry and Fire Protection, and DPR, is particularly apropos to the forthcoming effort to identify Traditional Cultural Properties (TCPs). This study discusses the ethnohistory and contemporary religious values of the Konkow with reference to culturally significant sensitive areas. The data are analyzed using environmental perception models. Management recommendations are offered for sites and areas considered sacred or significant to the world-view of the Foothill Konkow (Forbes 1989).

McCarthy's ethnographic/ethnohistoric study complemented the most recent DPR archaeological survey at Craig Saddle (Steidl et al. 1999). It was initiated because of the significant archaeological values attributed to the site concentration that has been threatened by vandalism. Additionally, the presence of two cemeteries and the persistence of an ethnographic name, Ta'a, to 1 of the village sites indicate special importance to the local Indian community. The study was entirely archival, entailing a review of published and unpublished ethnographic documents available for the area (McCarthy 1998).

Finally, Wilson and Towne (1972) prepared a bibliography on Maidu ethnography for the National Park Service. It is annotated and quite extensive for the period it covers.

4.8.3 Cultural Resource Sensitivity of the Lower Feather River

The project area downstream of the dam and spillway is located at the east edge of the Sacramento Valley between 100 and 300 feet in elevation. The terrain is typically the flat valley floor and rolling hill country of the low Sierra Nevada foothills. All of the archaeological sites are situated on or near the banks of the Feather River or on knolls overlooking the river.

Archaeological sites in this area indicate intensive occupation over a long time period: deep, stratified, multi-component midden deposits denoting village settlements, with associated cemeteries, structural depressions, and milling stations. Konkow names are known for several of the site locales.

The largest single gold placer field in the world, over 6,000 acres, is located along the bed of the Feather River to the south and west of the City of Oroville (Welts n.d.). The gold dredging industry originated at Oroville from whence it spread around the world (Hoover et al. 1966). Much of the material used to construct the Oroville Dam derived from these dredge tailings. Part of the Thermalito Facilities and the DFG Oroville Wildlife Area are situated in this area of dredge spoils.

Historic period features and sites typify homesteading, mining, river-crossing ferries, and a city refuse dump. Historic resources are significantly under-represented by site record documentation, typical of the 1960s when most of the archaeological surveys were carried out for the Lake Oroville Project.

4.8.3.1 Previous Studies

The initial archaeological survey in the lower Feather River project area was done in 1957 by an archaeologist from the University of California, Berkeley (Elsasser and Van Zandt 1957). The 1 site recorded was probably related to his research on the archaeology of the Sierra Nevada (Elsasser 1960).

Almost all of the subsequent studies were conducted by DPR and DWR related to construction, operation, and maintenance of the project facilities and appurtenances. With few exceptions, the most significant studies, including both surveys and “salvage” excavations, were undertaken between 1960 and 1965 by DPR archaeologists under agreement to DWR.

Additionally, field classes from American River Junior College carried out surveys and excavations (Gebhardt 1964) during 1963 and 1964 under DPR supervision (Olsen 1964). Two of the sites (BUT-157 and BUT-182) excavated by the field classes had a midden deposit at least several feet deep and had associated milling areas, structural remains, and a cemetery. Time sensitive artifacts and radiocarbon dates from these sites helped define a cultural sequence at least several thousand years old. The dates span the period from the earliest archaeological evidence of human occupation in the locality, the Mesilla Phase dated prior to AD 1, to the Oroville Phase dating from AD 1500 to 1850, representing the protohistoric period and ethnographically documented Konkow groups.

Small-area surveys during the mid-1970s resulted in the identification of a few new sites (Riddell 1975; Markley 1977; Manning 1998). No further work in the project area appears to have been done until the mid-1980s, when DPR archaeologists (Hines and Barter 1986; Hines 1987) embarked on a program to identify sites damaged by vandalism, visitor impacts, development, and natural erosion. Site records were updated and recommendations were made for site protection measures at vulnerable sites. Caltrans surveys during this period for the replacement of the State Highway 162 bridge (Offerman 1988; Offerman and Noble 1991) had negative findings.

The recent surveys for the Feather River Bike Trail Expansion Project (Jones & Strokes Associates, Inc. 1999a-d) resulted in the identification of five new historic period sites and the re-documentation of BUT-584/H, a prehistoric site with an historic component. These sites are located along the south bank of the Thermalito Diversion Pool across the river from the Feather River Fish Hatchery. They are the only sites in the project area that have been evaluated for eligibility to the National Register of Historic Places (NRHP); none qualified.

Another recent survey, a DWR construction debris clean-up project near the Oroville Fish Hatchery, covered some of the same area as the bike trail survey (Hunter et al. 2000). This survey redefined the site boundaries of BUT-584/H and BUT-69/H, a similar prehistoric milling site with historic ferry features on the opposite, north bank of the river near the fish hatchery.

Additionally, three sites, one prehistoric and two historic, are known in the Thermalito Forebay area, and three sites, one prehistoric and two historic, including the Oroville City refuse dump site (Orlins 1999), are known in the Oroville Wildlife Area.

4.8.3.2 Recognized Sites

The Table Mountain Boulevard Bridge (Caltrans Bridge No. 12-0221) is the only resource within the lower Feather River project area listed in the NRHP (Department of Transportation 1987). It is a 3-span steel truss bridge with stone and board-formed concrete abutments. It was built in 1908 by the Pacific Construction Company of San Francisco to replace the prior bridge washed away during the 1906-1907 Feather River flood (Green 1996).

A single site (BUT-12), the locale of Long's Bar, situated near the north bank of Thermalito Diversion Pool, was recognized by listing as a State Point of Historic Interest in 1981 (Office of Historic Preservation 2000a). It was the first mining camp on the Feather River. Peter Lassen and John Bidwell prospected there, and Major Frank McLaughlin diverted the river there with his famed rock wall (Butte County Historical Society 1981). Gold was found at Long's Bar in the fall of 1849 and the first pan washed out netted $400 (Hoover et al. 1966). In October of that year, the Long brothers opened a general store cum saloon, hotel, and bakery. Gambling halls and saloons became very numerous and "great heaps of gold were won and lost every day" (Wells and Chambers 1882). The town grew to be one of the principal settlements in the region during the early 1850s (Butte County Historical Society 1981).

Adamstown, another inundated mining camp, was established on the opposite bank of the river during the winter of 1849. The first ferry licensed to cross the Feather River plied between these two communities. The first religious ceremonies and the first Masonic meetings in the county were held at Long's Bar in the fall of 1849. The Oroville and Virginia City Railroad, starting construction of a route through the Feather River Canyon, passed by Long's Bar. The line was finished by the Western Pacific Railroad in 1910 with routes to Oakland and Salt Lake City (Butte County Historical Society 1981).

Typical of many other mining camps, by 1852 the town began to decline in importance and never regained its original prestige. By 1981, nothing was left but a picturesque site with some scattered piles of rocks and the pioneer cemetery which has the county's oldest tombstone, dating to 1849. The site was not relocated during the 1986 DPR survey to evaluate threatened sites under the Resource Management Program (Hines 1987).

4.8.3.3 Site Inventory

Of the 12 sites thought to exist in the project area prior to the 1986-1987 DPR re-survey, five could not be relocated and presumably are totally destroyed or inundated. Of the seven existing sites, two are milling feature sites and five are sites with a midden deposit. Human remains were found at three of these sites, and two have structural remains represented by housepit features. The midden deposits have all been badly damaged by human and natural means (Hines and Barter 1986; Hines 1987).

Thus, the Table Mountain Boulevard Bridge and a total of 20 sites have been recorded and are still thought to exist in the lower Feather River project area.

4.8.3.4 Archaeological Collections

Archaeological collections from six of the sites resulting from the DPR studies in the early 1960s are curated by DPR, Cultural Resources Division, Archaeology Laboratory, West Sacramento. A draft site report is on file with the collection from BUT-182 (Olsen and Riddell 1968); however, the other collections have not been described, analyzed, or reported.

4.9 RECREATIONAL RESOURCES

4.9.1 Regional Resources

4.9.1.1 Regional Overview

Discussion in this section is directed at placing the Lake Oroville State Recreation Area in a regional context as a recreation resource. After orienting the reader with the general location, areas within a one-and two- hour drive of Lake Oroville are discussed to help delineate the potential effect of project operations on recreational resources in the area. See Table 4.9-1 for summary of recreational opportunities for the region, vicinity, and area.

4.9.1.2 Lassen National Forest

Located approximately 40 miles northeast of the project, the Lassen Nation Forest (LNF) offers a variety of recreational experiences, including camping, hiking, bicycling, fishing and boating, wildlife viewing, and off-highway vehicle (OHV) driving. All campgrounds have fire rings, tables, and restroom facilities (LNF 2000).

4.9.1.3 Lassen Volcanic National Park.

Located on the southwest edge of the Lassen National Forest, the Volcanic National Park is approximately 40 miles from the project area and offers unique access to an “active” volcano. All four types of the world's volcanoes can be found at the park. Various recreation activities occur in the park including camping, hiking, sightseeing, and museum visiting. The park covers 106,000 acres of forested foothills and volcanic relics. Snow arrives early and stays late, which accounts for the park being operational just three months of the year. Lassen National Park is one of the least crowded of the national parks (LNP 2000).

4.9.1.4 Lake Almanor Recreation Area

The Lake Almanor Recreation Area, located approximately 50 miles northeast of the project area, includes Butt Valley Reservoir and Lake Almanor, which together offer 28,664 water surface acres and approximately 64 miles of shoreline for recreation. PG&E has provided a number of family and large group camping areas and picnicking/day use facilities at the Lake Almanor Campground, which has increased public recreation opportunities for fishing, swimming, boating, water-skiing, rental cabins, and summer homes. At this campground there are 130 campsites for tents or motor homes (PG&E 2000). The Lassen National Forest also manages a campground on Lake Almanor containing 103 campsites for tents or motor homes, piped-in water, vault toilets, picnic tables, and fireplaces (LNF 2000). Campgrounds and day-use facilities at Lake Almanor receive an estimated annual usage of more than 130,000 visitor days (PG&E 1997).

4.9.1.5 Bucks Lake Recreation Area

The Bucks Lake Recreation Area, approximately 20 miles northeast of the project, includes Grizzly Forebay, Three Lakes, Lower Bucks Lake, and Bucks Lake, together offering approximately 2,084 water surface acres and approximately 20 miles of shoreline for public recreation. The Bucks Lake Recreation Area provides recreational opportunities ranging from primitive camping to resort areas providing rental cabins and restaurant services. Other facilities at Bucks Lake include areas for group and family camping, picnicking, boating, water-skiing, fishing, and swimming. The Bucks Lake

Recreation Area provides a total of 66 camping units (PNF 2000). PG & E owns about half of the shoreline and the remainder is managed by the USFS, Plumas National Forest (PNF).

Table 4.9-1: Existing Recreation Opportunities in the Project Area, Vicinity, and Region*

Location	Operator	Public Use	Shoreline Access	Parking	Camping	Boating	Picnic	Cabins	Trailheads	Toilets	Information
Project Region											
Lake Almanor	PG&E	Yes	X	X	X	X	X	X		X	X
Bucks Lake	PG&E	Yes	X	X	X	X	X	X	X	X	X
Butt Valley Reservoir	PG&E	Yes	X	X	X	X	X		X	X	X
Plumas N.F.	USFS	Yes	X	X	X	X	X		X	X	X
Lassen N.F.	USFS	Yes	X	X	X	X	X		X	X	X
Lassen N.P.	NPS	Yes	X	X	X	X	X		X	X	X
Upper F. River Lakes	USFS	Yes	X	X	X	X	X		X	X	X
Project Vicinity											
North Fork Feather River Projects	PG&E	Yes	X	X	X	X	X	X	X	X	X
Gasner Bar Campground	USFS concession	Yes	X	X	X		X			X	X
North Fork Campground	USFS concession	Yes	X	X	X		X			X	X
Queen Lilly Campground	USFS concession	Yes	X	X	X		X			X	X
Project Area											
Kelly Ridge Visitor Center	DWR DPR	Yes	X	X					X	X	X
Loafer Creek Rec. Area	DPR	Yes	X	X	X	X	X	X		X	
Lime Saddle Rec. Area	DPR	Yes	X	X	X	X	X		X	X	
Freeman Bike Trail	DPR	Yes	X						X	X	
Oroville Wildlife Area	DFG	Yes	X	X	X		X				
Boat-In Camp Sites	DPR	Yes			X	X	X		X		
Floating Camp Sites	DPR	Yes			X	X	X		X		
Lime Saddle Marina	DWR concession	Yes	X	X		X	X			X	X
Bidwell Canyon Marina	DWR concession	Yes	X	X		X	X			X	X
Oroville Horse Trail	DPR	Yes									
Goat Ranch Boat-In Camp	DPR	Yes	X		X	X				X	
Vinton Gulch	DPR	Yes	X	X		X					
Dark Canyon	DPR	Yes	X	X		X					
Diversion Pool	DPR	Yes	X			X	X				
N. Therm. Forebay	DPR	Yes	X	X		X	X			X	
S. Therm. Forebay	DPR	Yes	X	X		X	X				

Therm. Afterbay	DWR	Yes	X	X		X	X			X	
Aquatic Center	**	No	X	X		X					
Clay Pit OHV Area	DPR	Yes		X			X				
Feather River Fish Hatchery	DFG	Yes		X			X				
Car-top Boat Ramps	DPR	Yes	X	X		X	X			X* **	
Crest of Dam	DPR	Yes	X	X			X		X		
Spillway Area	DPR	Yes		X			X				

**Note: An “X” indicates the presence of a facility or recreation opportunity at a particular site.*
***California State University Chico and Butte Sailing Club.*
****Seasonally.*

4.9.1.6 Butt Valley Reservoir

Butt Valley Reservoir is located approximately 46 miles to the northeast of the project, and four miles south of Lake Almanor at an elevation of 4,140 feet. At maximum pool level, the lake has 1,600 surface acres. Opportunities for recreation at Butt Valley Reservoir include camping, fishing, hiking, and swimming. Recreation facilities developed by PG&E at the reservoir are comprised of two campgrounds on the east side: Cool Springs and Ponderosa Flat. Cool Springs is a fee campground with 25 camp units and five walk-in units. It is located 2.5 miles south of Ponderosa Flat Campground on the east shore of Butt Valley Reservoir. Located on the north end of Butt Valley Reservoir, Ponderosa Flat is also a fee campground and contains 63 camp units. There is also a boat launch and day-use area at the facility. Powerboats are allowed on the reservoir; however, a Plumas County ordinance limits boat speeds to a maximum of 25 mph (Plumas County 1998).

4.9.1.7 Upper Feather River Lakes

Antelope, Frenchman, and Davis lakes, located 60 to 75 miles northeast of Oroville, are situated within the PNF and mark the beginning of the SWP. The USFS operates all recreational facilities at the three lakes.

Antelope Lake and Dam are located on Upper Indian Creek, a tributary of the North Fork Feather River. Camping, fishing (including handicapped access), picnicking, boating, water-skiing, swimming, hunting, hiking, snow skiing, and snowmobiling are recreational activities occurring on or around the lake. Sanitation and trailer dumpsites are available (DWR 1997).

Frenchman Lake and Dam are located on the Last Chance Creek, a tributary of the Middle Fork of the Feather River. The area offers similar activities and services found at Antelope Lake (DWR 1997).

Lake Davis and Grizzly Valley Dam are located on Big Grizzly Creek, a tributary of the Middle Fork of the Feather River. The area offers similar activities and services found at Antelope and Frenchman lakes (DWR 1997).

4.9.1.8 Area Trail Systems

The Pacific Crest Trail (PCT) extends across the PNF for about 75 miles, crossing two major canyons (the Middle Fork and North Fork of the Feather River). Trail elevations range from 2,400 to 7,000 feet above sea level (PG&E 1997). Mid-June is the earliest that it is usually feasible to hike in this area as snow is prevalent until then and streams run high.

4.9.2 Project Vicinity

Several recreational opportunities exist in the project vicinity, just upstream of the project. Intermittent opportunities for whitewater boating exist in the area but are dependent on rainfall and dam release for instream river flows. Driving tours of historical and scenic interest are included in the draw of tourists to the area, particularly related to the area's distinctive mining and train history in the Feather River Canyon. The Feather River Canyon offers two recreational gold panning sites, as well as opportunities for bird watching and wildflower viewing.

The Feather River Canyon offers hunting and fishing opportunities, but fishing along the shoreline of the river is constrained by rocky terrain that makes walking difficult. Hunters travel to the area seeking hunting opportunities for mule deer, bear, ducks, geese, quail, pigeon, and grouse. Rainbow trout fishing in the lower canyon is the primary attraction for people interested in fishing in the Feather River Canyon.

4.9.2.1 Plumas National Forest

Located adjacent to Lake Oroville, the forest covers over a million acres of tree-covered mountains with hundreds of lakes and thousands of miles of streams. The forest's headwaters flow into the project reservoir. Camping facilities include family car camp units, recreation vehicle (RV) hook-ups, and remote sites with minimal services. Most developed facilities include piped water, flush or vault toilets, stoves or fire circles, tables with benches, and parking spaces. The area is typically used for hiking, fishing, hunting, camping, mountain biking, rafting, snow sports, scenic drives, and wildlife viewing (PNF 2000).

4.9.2.2 Highway 70 Scenic Byway

State Highway 70 Scenic Byway begins 10 miles north of the project, runs through the Feather River Canyon, and offers spectacular views and countless points of cultural, geologic, and historical interest. It is a popular access route for the region's recreational opportunities. Highway 70 was officially dedicated in October 1998 as a Scenic Byway by the USFS and is eligible for State Scenic Highway status (PNF 2000).

4.9.2.3 Feather Falls Scenic Area

The Feather Falls National Recreation Trail leads to Feather Falls, the sixth highest waterfall in the continental United States and fourth highest in California. The 15,000-acre Feather Falls Scenic Area is located in the La Porte Ranger District of the Plumas National Forest. In respect to the project area, access to a nine-mile loop trail that leads to the Feather Falls Overlook is from Lumpkin Road in the South Fork arm of the reservoir. The trailhead has camping and toilets available.

4.9.2.4 Four-Wheel Drive Access

Other recreational opportunities in the Project Vicinity include four-wheel drive off-road vehicle (4WD/ORV) access along the dirt road which parallels Lake Oroville on its north shore. The primitive road begins just south of the Poe Powerhouse and ends near French Creek. The river can be accessed along certain portions of this road. Extensive PNF land is also available for ORV use. The forest plans for the Plumas and Lassen National Forests indicate that most federal forestlands in the project vicinity are open for ORV use (PNF 1988). For example, there is a 4WD road paralleling the North Fork Feather River, running northeast from the town of Pulga. Off-road vehicle travel is generally constrained to cleared roadways and is excluded from protected areas such as Bucks Lake Wilderness and the Pacific Crest Trail.

4.9.2.5 North Fork Feather River Hydroelectric Projects

This area includes four hydroelectric developments and their associated recreation opportunities along the North Fork of the Feather River from Lake Almanor to LOSRA.

The four hydroelectric developments include the Upper North Fork Feather River (UNFFR), Rock Creek, Cresta, and Poe. Lake Almanor Recreation Area and Butt Valley Reservoir are part of the UNFFR Project and are discussed in Section 4.9.1.

These projects are managed by PG&E and afford similar recreational opportunities. They provide public river access, parking, camping, and picnicking areas. Rock Creek, Cresta, and Poe all have small reservoirs with no developed facilities. Shady Rest, located near the Cresta Reservoir, is a highway rest stop developed by PG&E in 1962. Below Lake Almanor to Lake Oroville, whitewater boating opportunities are available on the North Fork Feather River and range in difficulty from Class III to Class V.

4.9.2.6 North Fork Feather River U.S. Forest Service Campgrounds

There are three USFS campgrounds along the North Fork Feather River. These include Gasner Bar, North Fork, and Queen Lilly campgrounds. The campgrounds are located approximately 18 miles northeast of the project area and are operated by the Plumas National Forest. Gasner Bar Campground is about two miles east of Belden Town along Highway 70, via Caribou Road. This campground contains 14 campsites, piped-in water, flush toilets, showers, fireplaces, picnic tables, space for trailer parking, and fishing opportunities (Stratton 1991).

4.9.2.7 Project Area

Lake Oroville is the second largest reservoir in California, after Lake Shasta. Existing facilities at the Oroville Complex host a wide variety of recreational opportunities. They include: boating (several types), fishing (several types), fully developed and primitive camping–including boat-in sites, picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife watching, hunting, and visitor information sites with cultural and informational displays about the developed facilities and the natural environment. There are major recreation facilities at Loafer Creek, Bidwell Canyon, the Spillway, Thermalito North and South Forebays, and Lime Saddle. There are also facilities at the Visitor Center, Themalito Afterbay, and the Oroville Wildlife Area. Additionally, there are two full-service marinas, five car-top boat launch ramps, ten floating campsites, and seven strategically placed floating toilets to provide for the practical needs of visitors. The locations of the Lake Oroville State Recreation Area facilities are shown Figure 1-1.

Lake Oroville is part of the SWP and is the responsibility of the DWR. The State Department of Parks and Recreation (DPR) manages the majority of recreational facilities at LOSRA including the Clay Pit State Vehicular Area. Exceptions to DPR management are: the Kelly Ridge Visitor Center, co-managed with DWR; the concessionaire-run marinas at Lime Saddle and Bidwell Canyons, and the fish hatchery and the Oroville Wildlife Area managed by DFG. The State Water Contractors work with the DWR to complete projects and manage the facility efficiently. A brief discussion of the DWR, DPR, and DFG planning documents for these areas is discussed in Section 4.11, Land Use and Management.

4.9.2.8 Lake Oroville Visitor Center

Located east of the Oroville Dam on Kelly Ridge, the 10,000 square-foot, award winning Visitor Center features exhibits on the engineering and construction of the hydropower facilities including the dam and explains how the Oroville Complex distributes water and electrical power to its destinations. There are interpretive displays on the native culture and the natural resources of the area. The Visitor Center hosts individual visitors as well as large groups such as K-12 school field trips. In addition to the informational displays inside of the Visitor Center, there is a 47-foot viewing tower that provides a panoramic view of the lake and its surroundings. The Visitor Center is universally accessible and has picnic tables, shade trees and shelters, drinking fountains, a gift shop, a telephone, a restroom, and parking for automobiles and busses. The Dan Beebe equestrian trail can be accessed from the Visitor Center.

4.9.2.9 Loafer Creek Recreation Area

This is a major recreation area on the southern shoreline of the reservoir, on the east side of Bidwell Canyon. Within this complex is a family campground, a group campground, a horse camp, a day-use site, and a boat launch ramp. Each of the 137 family campsites has a picnic table, a fire ring, a parking space, and nearby restrooms, showers, telephone, and potable water. Each of the group camps has five tent sites, a large BBQ pit, picnic tables, a food storage locker, fire pit, and sink with running water. Restroom facilities and hot showers are nearby. Each group site accommodates a maximum of 25 persons and parking for eight vehicles. The horse camp features 15 sites, a restroom, showers, a horse washing station, and horse tethering and feeding stations near each campsite. The large day-use site (80 tables) has picnic tables, BBQ stands, a swim beach, bathrooms, showers, and parking for 248 vehicles. The seasonal, eight-lane boat launch ramp has a large parking area for 14 cars and 177 car/trailer combinations.

4.9.2.10 Lime Saddle Recreation Area

This area is located on the western shoreline of the West Branch of the North Fork arm of the reservoir. Recent improvements to the Lime Saddle Recreation Area include an improved boat ramp, more parking, lighting, restrooms, a fish cleaning station, and better landscaping. Under construction is a campground with 51 tent/RV units. Under design is a parking lot with approximately 50 spaces.

4.9.2.11 Marinas: Lime Saddle and Bidwell Canyon

Lime Saddle Marina is concessionaire-operated and offers a variety of boats to rent including houseboats, patio boats, and fishing boats. There is a boat-launching ramp, a day-use area, picnic facilities, fishing and boating supplies and services, gas and oil, a snack bar, general store, and toilets (DWR 2000).

Bidwell Canyon is a major recreation area with family campsites, both tent and RV, with parking, picnic tables, fire rings, potable water, and toilets. The Bidwell Canyon Marina offers boat rentals, groceries, fishing supplies, a snack bar, covered slips and open mooring, a fuel dock, a pumping station for boat holding tanks, boat storage, trailer facilities with hookups, and a boat ramp (DWR 2000).

4.9.2.12 Freeman Bicycle Trail

The Freeman Bicycle Trail provides 41 miles of scenic off-road recreation for all-terrain bikes. The trail circles the North and South Thermalito Forebays, Thermalito Afterbay, and the crest of Oroville Dam. About 30 miles of trail are mainly flat but include some rolling terrain. Steep grades are found on either side of the dam within a few miles of Lake Oroville. The trail has been used for downhill and cross-country races (DWR 2000).

4.9.2.13 Lake Oroville Horse Trail

Equestrians can camp out with their equine companions at a facility built just for them. The site has pullouts for horse trailers, horse showers, feeder stalls, and a bathroom/ shower complex for humans. The area also has over 20 miles of riding and hiking trails rising from an elevation of 200 feet to 1,000 feet (DWR 2000).

4.9.2.14 Oroville Wildlife Area

The Oroville Wildlife Area teems with wildlife, including many species of fish and birds. Bird-watchers can look for 178 species, including heron and egret rookeries from February to June. There is limited hunting in the wildlife area for turkeys in the spring. Fishing, swimming, and primitive campsites are also available (DWR 2000). This area is managed by the DFG.

4.9.2.15 Camping: Boat-In Sites and Floating Sites

The North Fork, Goat Ranch, Foreman Creek, Craig Saddle, and Bloomer primitive recreation areas have boat-in camps, reachable only by boat. Each camp contains several individual campsites. The sites are cleared and leveled for pitching tents. Pit toilets, garbage cans, tables, and fire rings or stoves are at each site. No water is piped-in (DWR 2000).

The floating campsites are anchored in different areas of the lake, such as at the Potter Ravine Recreation Area. Each is a two-story structure with living space and amenities such as a gas grill, camp table, sink, restroom, shelves, storage room, cabinets, and a sleeping area. User brings potable water although sink water is provided (DWR 2000).

There are several floating sanitary stations (toilets) around the reservoir. These are operated in order to decrease water pollution and facilitate the needs of boaters.

4.9.2.16 North Thermalito Forebay Recreation Area

Located on the northern shoreline of the forebay, the North Thermalito Forebay Recreation Area offers a 300-acre day-use area for picnicking, barbecuing, fishing, and swimming. Restrooms and phones are available, as are dressing rooms, potable water, and parking. Boating is restricted to non-powerboats such as sailboats and canoes (DWR 2000).

4.9.2.17 South Thermalito Forebay

Located on the southern shoreline of the forebay, the South Thermalito Forebay has picnic tables, stoves, potable water, boat launch ramps, toilets, a swim beach, and a fish cleaning station. Power boating and fishing are the forebay's main uses (DWR 2000).

4.9.2.18 Thermalito Afterbay

With 17 miles of shoreline and 4,300 surface acres of water, Thermalito Afterbay is open for boating, swimming, fishing, picnicking, and limited hunting. There is also a boat ramp and toilets at the Monument Hill site on the eastern shoreline of the afterbay. The afterbay is adjacent to the Oroville State Wildlife Area and the Feather River Fish Hatchery Annex (DWR 2000).

4.9.2.19 Car-Top Boat Ramps

The Enterprise and Stringtown areas are located on the South Fork arm of the reservoir. Dark Canyon, Vinton Gulch, and Nelson Bar are located on the north end of the reservoir. These areas were minimally developed to allow the launching of boats onto the reservoir. There may be toilets at some of the ramps available during peak holidays such as Memorial and Labor Day (DWR 2000).

4.9.2.20 Diversion Pool

The Diversion Pool consists of the 4.5-mile stretch of the Feather River from the Oroville Dam to the Thermalito Diversion Dam. This area above the Forebay is open for day-use activities such as swimming and picnicking. Only non-motorized boats are allowed. This area is open seasonally (DWR 2000).

4.9.2.21 Low Flow Section of the Feather River

The section of river between the Fish Diversion Dam and Thermalito Afterbay is commonly referred to as the Low Flow Channel of the Feather River. This section of the river runs past the City of Oroville, the Clay Pit Off-Road Vehicle Area, and the Oroville Wildlife Area. It flows southwest under Highway 162 and along Highway 70 adjacent to the City of Oroville, and meets the outflow from Thermalito Afterbay. This river section is considered low flow because much of the water that is released from Lake Oroville is diverted to the Thermalito Forebays and the Afterbay.

This section of the Feather River is an important recreational resource for the residents of Oroville and the nearby residential areas. Access is available south of the City of Oroville, off of Highway 70. The river is closed to fishing north of the Table Mountain Bicycle Bridge. The river is open for fishing seasonally based on DFG regulations. In the spring and fall, salmon are known to congregate at the Thermalito Afterbay outlet hole. In recent years the Feather River has hosted 40,000 king salmon in the spring and fall. Several types of fish are sought by anglers in this section of the river with a good success rate (Steinstra 1999). The Low Flow Section of the river is also used and enjoyed by swimmers, wildlife and bird watchers, sightseers, hikers, and bicyclists. The Brad P. Freeman Bicycle Trail runs beside this section of river from the Diversion Dam to Highway 162 where it heads west. Below the Thermalito Afterbay outlet, the river continues through the Oroville Wildlife Area where it gains water from the Afterbay outflow.

4.9.2.22 Aquatic Center

California State University at Chico and the Butte Sailing Club operate the Aquatic Center at North Thermalito Forebay. The 1,200-square-foot facility provides area sailing clubs with a boathouse and an area for holding classes (DWR 2000).

4.9.2.23 Feather River Fish Hatchery

Salmon migration up the river is stopped at the Fish Barrier Dam. They climb the fish ladder into the hatchery where the DFG can access the fish to maintain healthy populations. The barrier dam can be viewed from an observation platform, and visitors can get an underwater view of the fish swimming up the ladder (DWR 2000).

4.9.2.24 Clay Pit State Vehicular Area

Clay Pit State Vehicular Recreation Area provides good beginner terrain for off-road enthusiasts. The clay used to build Lake Oroville was taken from the Feather River Valley, three miles west of Oroville. The resulting depression – a large shallow pit ringed with low hills – is the site of this 220-acre recreation area. It is a motorcycle, all-terrain vehicle, and dune buggy use area. This area also has a rifle range (DPR 2000b).

4.9.2.25 Crest of the Dam

Located on the southwest shoreline of the reservoir, the crest of the dam can be utilized for driving, jogging, bicycling, or rollerblading. This is the tallest earthfill dam in the nation with a height of 770 feet (DWR 1999). At night, lights accent the 6,920-foot-long roadway along the dam's crest to facilitate some evening recreation.

4.9.2.26 Spillway Area

Development consists of boat launching ramps and parking areas at two levels to accommodate seasonal water level changes. This is the largest launching facility at Lake

Oroville (DWR 1997). There are boat docks, toilets, picnic sites, and parking spaces on the lower level to accommodate overnight parking for self-contained recreational vehicles.

4.9.3 Recreational Resources and Lake Level

4.9.3.1 Lake Level Effects

Lake Oroville provides many year-round recreation opportunities such as fishing and boating. Recreation areas are spotted around the lake and boaters can land at any point to explore the surrounding country. However, there are specific recreation facilities that have their usefulness limited during times of low water. During years with low runoff into the reservoir (e.g., mid-1980s through early 1990s), combined with project operations, can result in extremely low water levels. Boat ramps at the project were not designed to work under such extremes. It was for this reason that the ramps at Bidwell Canyon and Lime Saddle were extended and the Spillway ramp was modified to facilitate launches at low water.

When the reservoir is at its maximum elevation, it includes some 15,810 acres for recreation and 167 miles of shoreline. For the water year 1999-2000, the level of the lake was 853 feet above sea level in April–at the beginning of the recreation season. At the end of the recreation season (September), the level of the lake was 786 feet above sea level (a 67-foot difference). This difference amounts to lake levels that vary considerably, preventing the use of certain recreational facilities during low water and making shoreline exploration difficult. As the level declines during the ensuing recreation season, the use of certain recreation facilities such as boat launch ramps, car-top boat launches, and boat-in camps are increasingly affected.

4.9.3.2 Boat Launch Ramps

There are four major boat launch ramps at Lake Oroville: Bidwell Canyon, the Dam Spillway, Loafer Creek, Lime Saddle, and one minor ramp, Enterprise. Bidwell Canyon has a six-lane ramp; four of the six lanes are usable at low water. The Dam Spillway has two ramps, a 12-lane and an eight-lane ramp. The 12-lane ramp is used when the water is high during heavy recreation use. The eight-lane ramp is used when the water is low and recreation use drops off. Loafer Creek has an eight-lane ramp used when the lake level is high. It is closed during low water when recreation use drops off. Lime Saddle has a five-lane boat launch ramp that is used all year. Enterprise has a two-lane ramp that is not used when the lake level is low.

4.9.3.3 Car-Top Boat Launch Ramps

There are five car-top ramps: Vinton Gulch, Stringtown, Nelson Bar, Dark Canyon, and Foreman. Stringtown and Dark Canyon ramps are usable at low water. Nelson Bar is not usable during low water.

4.9.3.4 Boat-In Camps

Several boat-in camps are located around the lake, reachable only by boat: (1) Bloomer with its Cove area, Knoll area, Point area, and Group area; (2) Craig's Saddle area; (3) Foreman Creek area; and (4) Goat Ranch area. They are open all year, but low water levels affect the use of these camps. As the water level drops, the short walk that would occur during high water from the boat becomes a strenuous hike, especially if one is carrying camping gear. If the hike is not long, it can still be steep and hazardous (e.g., Bloomer). Large signs located at the beach area adjacent to the site, seen as the boater approaches, identify the boat-in camps. The signs are difficult to find and read when the water is low.

4.9.3.5 Other Low Water Effects

Another aspect of the low lake level is that the "bathtub ring" marking the shoreline at low water can detract from the scenic qualities of the reservoir, and thus reduce the quality of the visitor's experience. For example, in the case of the 10 floating campsites moored adjacent to the shoreline, the "bathtub ring" is part of the sites' immediate foreground.

Low water level also increases the difficulty of reaching some recreation sites, such as the spectacular Feather Falls. Located on Fall River, Feather Falls is one of the scenic highlights of the area on the Middle Fork arm of the lake. Feather Falls is 640 feet high and is especially beautiful during the spring run-off. When the lake is at its maximum elevation (May in water year 1999-2000), you can boat within a quarter of a mile of the falls. When the lake level is down, one would have to walk a greater distance to the site.

4.9.4 Recreational Use

Lake Oroville State Recreation Area (LOSRA) hosts several types of recreation activities supported by the developed facilities at the site, including: fishing, camping, horseback riding, bicycling, off-road vehicle riding, sightseeing, hiking, and hunting. A 1997 recreation visitor survey showed that activities related to boating, fishing, and camping are some of the more popular activities in the area.

4.9.4.1 Boating

There are several types of boating activities that occur at LOSRA such as houseboating, water- skiing, personal watercraft (PWC), small motorized fishing boats, large powerboats, and non-motorized boats such as sailboats (and windsurfers), canoes, and kayaks. In the Chico State University "Recreation Use Study" (1987), fishing from a boat was the number one recreation activity at LOSRA, waterskiing was second, pleasure boating was third, houseboating was seventh, and PWC use was eighth. Boating is clearly one of the main reasons that visitors and residents come to LOSRA.

There are two concessionaire-run marinas that support the needs of boaters including rentals of almost every type of boat. The Bidwell Canyon Area is the primary marina and one of the large boat ramps, and campgrounds are located nearby. On summer days, there are large groups of pleasure boats and waterskiers in the vicinity of Bidwell Canyon. Also, a popular boating spot is the South Fork arm of the lake between the Stringtown and Enterprise car-top boat launch ramps. Lime Saddle Marina is on the less-crowded northwest arm of the lake and is preferred by many boaters because it affords easy access to the upper arms of the lake.

There have been periodic PWC competitions at South Thermalito Afterbay (e.g. May 21, 1995). There have also been events where large numbers of people, in boats, attend fireworks presentations on the lake (e.g. July 4, 1996). Lake Oroville hosts a lot of boaters from other areas who camp in one of the LOSRA campsites. Because many of the campers have boats in-tow, it is presumed that a lot of the campers come to LOSRA for the purpose of boating.

The North Forebay allows the use of sailboats, canoes, and other non-power driven boats; motors are not permitted. One of the results of this rule is that boaters who are interested in a quieter fishing, or calmer canoeing experience available at most parts of Lake Oroville, gather at this part of LOSRA.

4.9.4.2 Fishing

The LOSRA hosts a wide-variety of fishing for almost every type of angler. Lake Oroville is commonly known as a two-story fishery because there are warm water varieties near the surface and colder-water varieties deeper in the lake. For example, the warm-water fishery has spotted bass, largemouth bass, smallmouth bass, redeye bass, bluegill, green sunfish, black crappie, white crappie, channel catfish, and white catfish. Spotted bass are among the most commonly caught fish in Lake Oroville. The cold-water fish include brown trout and Chinook salmon. Rainbow trout are caught less frequently. The salmon numbers have increased in the last few years to the highest sustained levels in Lake Oroville's history. Catch rates have also been increasing (DWR 2001). See Section 4.5.2.1 for further discussion of the Lake Oroville Fishery.

A lot of the cold-water fish are caught from boats and the shore of the lake, but they are also caught in the rivers and creeks that are tributaries of Lake Oroville, as well as river sections below the dam. Anglers are often interested in the quieter coves of the lake, where the waterskiers have trouble navigating. Anglers also seek the quieter tips of the arms, too far out of the way for most of the social boaters who are interested in being near other boaters.

The Oroville Wildlife Area provides access to the majority of the upper reaches of the mainstem Feather River (below the dam), which is the most popular area for steelhead and salmon fishing on the river. This area also has numerous ponds that hold many of the same warm-water species as in Lake Oroville. The Thermalito Afterbay Outlet, located within the Oroville Wildlife Area, is the most popular fishing spot in Butte County, hosting tens of thousands of anglers each year. Anglers tend to fish with lures and bait here (Stienstra 1999). Anglers using fly- fishing setups fish the Feather River section along the Oroville Wildlife Area in the late fall through spring. The Oroville Wildlife Area also hosts limited hunting for turkey at specified times of the year and is also a popular duck hunting area during duck hunting season.

In recent years, there have been approximately 44 annual fishing tournaments at Lake Oroville. Private businesses, organizations, or clubs sponsors all of the tournaments. All of the tournaments are competitions for bass. Anglers compete in these events every month of the year. Some of the tournaments have hundreds of competitors.

4.9.4.3 Camping

There are four types of campers at Lake Oroville: recreational vehicles (RV) campers, car campers, boat-in campers, and floating campsite campers. Those with RV's have designated sites within several of the developed campsites and have the ability to camp in a self-contained manner (without hookups) at several of the boat launch ramps such as the Spillway. It is not known if the majority of the RV users have LOSRA as their sole destination or if they stop here on their way to another destination.

Car camping is available at several of the developed sites throughout LOSRA. As mentioned, many of the car campers have boats in tow, thus it is presumed that they are camping at LOSRA, in part, for the purpose of boating opportunities. Associated with the car camping areas are often nature trails (e.g. Loafer Creek) and day-use areas such as beaches or picnic areas

The floating campsite campers reach their sites via boat and take part in all of their out of camp activities with the use of a boat. Typically the users of these sites are groups of 5-10 people (a maximum of 15 is recommended), often are families, and have more than one boat for use. It is presumed that the users of these sites focus their trip on water-related events such as fishing or water-skiing.

The boat-in campsite campers usually use the sites during high water because the camps are much easier to reach from the water. This has been one of the main deterrents for the steady use of these sites. These camps offer the most primitive type of camping experience available at LOSRA. It is assumed that these campers partake in other activities such as shoreline fishing, swimming, or hiking.

4.9.4.4 Visitor Survey

Recreationists were surveyed in 1997 by California State University Chico Foundation researchers and asked about their recreational use at LOSRA. Among other things, researchers inquired about the amount of visitor use, when use occurred, types of activities, with whom visitors recreated, satisfaction, and likelihood of returning to LOSRA.

In 1997, recreation use at the LOSRA was estimated at almost 1 million visitors. The majority of activity occurs at Bidwell Canyon, the Spillway, and Lime Saddle (Table 4.9-

2). Overall, recreation at LOSRA is water-oriented (Table 4.9-3). Boating-related activities were the primary activity of a majority of the visitors at the LOSRA. The three activities that visitors stated most often as their primary activity were fishing from boat (25 percent), waterskiing (21 percent), and pleasure boating (18 percent).

Almost 30 percent of the survey participants recreated at LOSRA with their family. Overall, visitors appeared to enjoy their experience, with approximately 93 percent stating that they were satisfied with their LOSRA experience. Over 97 percent of those surveyed would have recommended LOSRA to a friend and 99 percent said they were likely to return to LOSRA.

Table 4.9-2: Total Estimated Visitor Days

Location	**Visitor Days**	**Percent**
Bidwell Canyon	208,856	20.7%
Spillway	205,155	20.6%
Lime Saddle	131,329	13.2%
Loafer Creek	102,739	10.3%
North Forebay	93,731	9.4%
Monument Hill	58,060	6.0%
Nelson Bar	33,346	3.3%
South Forebay	32,407	3.3%
Larkin Road	28,911	2.9%
Dark Canyon	25,056	2.5%
Stringtown	23,667	2.4%
Enterprise	19,172	1.9%
Foreman Creek	17,704	1.8%
Vinton Gulch	10,535	1.1%
Wilbur Road	6,528	0.7%
Total	**994,196**	**100.0%**

Table 4.9-3: Primary and Secondary Activities

Activity	Primary	Percent*	Secondary	Percent*
Fishing from boat	343	25.2%	211	15.5%
Water-skiing	285	20.9%	171	12.6%
Pleasure boating	249	18.3%	203	14.9%
Swimming/wading	231	17.0%	253	18.6%
Resting (kicking back)	197	14.5%	267	19.6%
Picnicking	138	10.1%	192	14.1%
Houseboating	128	9.4%	71	5.2%
Jet skiing	117	8.6%	84	6.2%
Fishing from shore	104	7.6%	101	7.4%
Camping	82	6.0%	82	6.0%
Beach use	67	4.9%	166	8.5%
Walking / jogging	66	4.8%	80	5.9%
Sightseeing	56	4.1%	123	9.0%
Other	51	3.7%	5	0.4%
Vacationing	22	1.6%	97	7.1%
Bicycle riding	21	1.5%	35	2.6%
Nature study	16	1.2%	36	2.6%
Photography	15	1.1%	49	3.6%
Windsurfing	8	0.6%	3	0.2%
Fishing tournament	1	0.1%	14	1.0%
**Percent based on 1,361 total respondents to this question*				

4.10 SOCIOECONOMICS

Socioeconomic conditions and characteristics that could be affected by the project include regional and local population levels, employment conditions, income levels, and fiscal characteristics. Conditions are described for the regional and local economy.

4.10.1 Regional Economy

Project facilities are centrally located in Butte County along the eastern side of the Sacramento Valley. Socioeconomic activity generated by recreational use of these facilities is concentrated within the county, although, as described below, some visitors to the Lake Oroville State Recreation Area pass through adjacent counties on their way to these facilities. The following discussion of regional socioeconomic parameters focuses on conditions within Butte County.

4.10.1.1 Population

The population of Butte County totaled an estimated 204,000 residents at the beginning of 2000 (California Department of Finance 2000). The county is largely rural, with slightly more than 50 percent of its population residing within unincorporated areas. As shown in Table 4.10-1, population centers within the county include Chico, Paradise, and Oroville. Growth within Butte County has been steady over the past 10 years, although it has lagged behind statewide growth rates. Since 1981, Butte County's population has increased at an average annual rate of 2.0 percent, compared to 2.2 percent statewide. Much of the recent growth within Butte County has occurred in Chico, which has experienced a 5.3 percent annual population growth rate since 1981.

Population growth in Butte County is projected to accelerate in the future, with the county's population projected to increase by 50 percent, to 307,300 residents, by 2020 (California Department of Finance 1998). The 2.5 percent annual average growth rate projected for the county between 2000 and 2020 would exceed the 1.6 percent growth rate projected for the statewide population.

Table 4.10-1: Historical and Projected Population Levels for Butte County and Local Communities

Area	1981	1990	2000	Annual Average Growth Rate 1981-2000
Biggs	1,390	1,540	1,750	1.4%
Chico	27,750	39,750	55,440	5.3%
Gridley	4,000	4,630	5,040	1.4%
Oroville	9,200	11,850	12,650	2.0%
Paradise	22,550	25,150	26,310	0.9%
Unincorporated	81,900	90,650	102,860	1.3%
Butte County Total	146,800	180,400	204,000	2.0%
Sources: California Department of Finance 1990, 2000.				

4.10.1.2 Labor Force and Employment

Butte County's civilian labor force averaged 85,700 persons during 1999, of which 79,900 (93 percent) were employed. During 1999, the county's unemployment rate averaged 6.8 percent, which ranked 31st among California's 58 counties. By contrast, the statewide unemployment rate averaged 5.2 percent during 1999 (California Employment Development Department 2000a). As shown in Table 4.10-2, estimated unemployment rates varied widely within Butte County during 1999, ranging from 5.0 percent in Paradise to 15.1 percent in the unincorporated South Oroville area.

Civilian employment by industry within Butte County, which averaged an estimated 71,300 jobs in 1999, is presented in Table 4.10-3. Key major industrial sectors include the services sector (30.3 percent of all jobs), the retail trade sector (20.1 percent), and the government sector (21 percent). Sub-sectors that could be sensitive to changes in visitation prompted by future changes in project operations or facilities include eating and drinking places (7.3 percent of countywide employment), food stores (3.3 percent), and hotel and other lodging places (0.7 percent). Recreation- and tourism-related travel expenditures in Butte County generated an estimated 3,300 jobs within the county in 1998, according to a study of travel-related impacts on California counties (Dean Runyan Associates 2000). These jobs accounted for an estimated 4.7 percent of Butte County's 1998 civilian employment.

Industrial employment within the county grew by an average of 1,060 jobs per year, or at an annual average rate of 1.7 percent, between 1990 and 1999. By comparison, the county's labor force increased by an average of 640 persons, or by an annual average rate of 1.0 percent, over the same time period (California Employment Development Department 2000c).

Table 4.10-2: Labor Force and Employment Estimates for Butte County and Selected Local Areas, 1999

Area	Labor Force	Employment	Unemployment	Unemployment Rate
Butte County	85,700	79,900	5,800	6.8%
Chico-City	22,740	21,330	1,410	6.2%
Gridley-City	2,040	1,800	240	11.7%
Oroville				
City	4,290	3,870	420	9.7%
East-CDP	3,700	3,480	220	6.0%
South-CDP	2,660	2,260	400	15.1%
Palermo-CDP	2,280	2,080	200	9.0%
Paradise-Town	10,370	9,850	520	5.0%
Thermalito-CDP	2,450	2,190	260	10.5%

CDP: Census Designated Place.
Note: Sub-county estimates were developed based on labor force and employment relationships measured during the 1990 census. Thus, the estimates may not be highly accurate.
Sources: California Employment Development Department 2000a, 2000b.

Table 4.9-3: Annual Average Civilian Employment by Industry in Butte County, 1999

Industry	Employment	Percent of Total Employment
Farm production and services	3,200	4.5%
Construction and mining	2,600	3.6%
Manufacturing	5,700	8.0%
Transportation and public utilities	2,900	4.1%
Wholesale trade	2,200	3.1%
Retail trade-total	14,300	20.1%
General merchandise	1,800	2.5%
Food stores	2,300	3.3%
Eating and drinking places	5,200	7.3%
Other retail places	5,000	7.0%
Finance, insurance, and real estate	3,800	5.3%
Services-total	21,600	30.3%
Hotel and other lodging places	500	0.7%
Amusement and recreation services	1,700	2.4%
Other services	19,400	27.2%
Government	15,000	21.0%
Total	71,300	100.0%
Source: California Employment Development Department 2000c.		

4.10.1.3 Income

Personal income received by Butte County residents totaled approximately $4.0 billion (in 2000 dollars) in 1998, which represented a 4.0 percent increase over the previous year. Per capita income levels within the county have generally lagged behind statewide levels. In 1988, per capita income within Butte County was approximately $20,840, which ranked 37th among California counties. By comparison, per capita income statewide was approximately $28,160 in 1998 (Bureau of Economic Analysis 2000).

Recreation- and tourism-related travel expenditures in Butte County generated an estimated $47.1 million in payroll expenditures within the county in 1998, according to a study of travel-related impacts on California counties (Dean Runyan Associates 2000).

These payroll expenditures represent an estimated 1.2 percent of total income within Butte County in 1998.

4.10.1.4 Recreation- and Tourism-Related Spending

Recreation and tourism generates economic activity within the region through travel-related expenditures by visitors on goods and services. According to a study of county travel impacts, travel expenditures in Butte County totaled $290.1 million in 1998 (Dean Runyan Associates 2000).

The LOSRA is the largest water-based recreation site in the region, attracting visitors from throughout the state. Based on a recent survey of LOSRA users, visitation to the recreation area totaled an estimated 994,200 visitor days in 1997, generating about $5.7 million in local expenditures (Guthrie, Penland, and Seagle 1997). (Local expenditures were defined as spending in the LOSRA, Oroville, and Paradise.) Local spending averaged $5.69 per visitor-day.

The survey results indicated that much of the local spending was generated by persons residing within Butte County, with an estimated 61 percent of the LOSRA visitors originating from areas within the county. Residents of adjacent counties (i.e., Colusa, Glenn, Plumas, Sutter, Tehama, and Yuba) accounted for an estimated 9 percent of LOSRA visitation. Resident locations of the remaining visitors included the San Francisco Bay Area region (14 percent), the Sacramento/Stockton region (10 percent), other in-state locations (4 percent), and out-of-state locations (2 percent).

4.10.2 Local Economy

The recreational use of the LOSRA generates socioeconomic activity in nearby communities. Incorporated communities located near project facilities include the cities of Oroville, Paradise, and Biggs. Additionally, a number of unincorporated communities and residential areas are located near Lake Oroville and the Thermalito Forebay and Afterbay. These include Yankee Hill, Old Yankee Hill, Pentz, Cherokee, Oregon City, Hurleton, Berry Creek, Wyandotte, and Big Bend near Lake Oroville, and Thermalito near the forebay and afterbay. Socioeconomic data are generally unavailable for the unincorporated communities but are noted where available.

4.10.2.1 Population

The Town of Paradise, located north of Lake Oroville, is the largest community in the vicinity of the lake. With an estimated population of 26,310 at the beginning of 2000, Paradise accounted for 12.9 percent of Butte County's population (Table 4.10-1). Paradise has been the county's slowest-growing community over the past 20 years, with an annual growth rate averaging 0.9 percent since 1981.

The City of Oroville, located approximately eight miles southwest of Oroville Dam, is the second largest community near the project facilities. Oroville's population totaled an estimated 12,650 residents at the beginning of 2000, accounting for 6.2 percent of Butte County's population. The city's population growth rate has been moderate in recent years, mirroring the county's rate of two percent since 1981 (Table 4.10-1). The nearby community of Biggs, with an estimated population of 1,750, is the only other incorporated community near the project facilities. Among the unincorporated communities, Thermalito (situated immediately west of Oroville) is the largest community.

4.10.2.2 Labor Force and Employment

Labor force and employment estimates for local areas within Butte County are summarized in Table 4.10-2. Paradise has the county's second largest labor force, estimated in 1999 at 10,370 persons. With an estimated 9,850 of its residents employed, Paradise had an estimated unemployment rate of 5.0 percent in 1999, well below the countywide rate of 6.8 percent.

The City of Oroville's labor force totaled an estimated 4,290 persons in 1999. Additionally, the unincorporated areas east and south of Oroville together had an estimated 1999 labor force of 6,360. Collectively, the Oroville area's labor force accounted for an estimated 12.4 percent of Butte County's total labor force. Unemployment in the Oroville area was generally higher than the countywide rate in 1999, with estimated unemployment rates of 9.7 percent in the City of Oroville and 15.1 percent in the south Oroville area. Unemployment in the east Oroville area was relatively low, an estimated 6.0 percent in 1999. The unemployment rate of the unincorporated community of Thermalito, with a labor force of 2,450 persons, was an estimated 10.5 percent in 1999.

4.10.2.3 Income

Recent income estimates are unavailable at the sub-county level. Based on 1999 unemployment rates within Butte County, however, per capita incomes in the Oroville and Thermalito areas are likely lower than the countywide 1998 per capita income of $28,160 because unemployment rates in these areas are generally higher than countywide unemployment rates. Conversely, per capita income in Paradise, which has a relatively low unemployment rate, is likely higher than countywide per capita income.

4.10.2.4 Recreation- and Tourism-Related Spending

Visitation to the LOSRA generates spending in communities near recreation areas. As discussed previously, visitation to the LOSRA generated an estimated $5.7 million in spending within the LOSRA and in the cities of Oroville and Paradise in 1997 (Guthrie, Penland, and Seagle 1997). The distribution of this spending among local communities is likely somewhat affected by the sites visited by LOSRA visitors. Approximately 52 percent of the local spending is associated with visits to recreation sites at the southern end of the LOSRA near Oroville, such as the Bidwell Canyon, Spillway, and Loafer Creek sites. Spending associated with use of sites such as Lime Saddle, Nelson Bar, Dark Canyon, and Vinton Gulch at the northern end of the LOSRA, which is closer to Paradise, accounts for an estimated 20 percent of total local spending. Visitation to recreation sites at the Thermalito Forebay accounts for about 13 percent of local spending. The remaining 15 percent of spending is associated with use of sites elsewhere throughout the LOSRA.

As discussed previously, an estimated 61 percent of the visitation to the LOSRA originates from residential locations within Butte County, including Oroville (18 percent), Chico (15 percent), Paradise (10 percent), Wyandotte (8 percent), and Magalia (4 percent).

4.10.3 Fiscal Conditions

Recreation and tourism within Butte County create tax revenues for the county and local incorporated communities by generating expenditures on lodging and taxable goods and services. According to a study of county travel impacts, travel expenditures in Butte County generated an estimated $3.3 million in local tax revenues in 1988 (Dean Runyan Associates 2000).

Butte County's sales and use tax rate is currently 7.25 percent, including a 1 percent portion that is directed to the general funds of governments in which taxable sales occur. Taxable sales within the county totaled approximately $1.9 billion in 1999. Approximately 75 percent of these sales occurred within incorporated communities, including Chico, Paradise, Oroville, Gridley, and Biggs (State Board of Equalization 2000).

Recreation use of Lake Oroville project facilities generates tax revenues for local governments. Based on estimated annual local spending of $5.7 million generated by visitation to the LOSRA (Guthrie, Penland, and Seagle 1997) in 1997, sales tax revenues generated for local governments (i.e., Butte County, Oroville, and Paradise) totaled an estimated $42,000, assuming 75 percent of travel-related expenditures were taxable. Visitor spending also generates transient occupancy tax revenues for local governments.

4.11 LAND USE AND MANAGEMENT

This section describes the land ownership patterns, land use and management plans and policies, and shoreline development and management of the project area.

4.11.1 Land Use Overview

4.11.1.1 Regional Land Use

The project is located within the unincorporated portions of Butte County, California, approximately 75 miles north of Sacramento. Lands in the region are managed by a variety of federal, state, and local entities. Major land and resource managers in region include the USFS, DPR, BLM, DFG, Butte County, and the City of Oroville.

The vast majority of the land use in the region is used for agriculture, timber, and grazing. Only 70 square miles (or four percent of all land) in Butte County is devoted to urban uses. The urban areas of Chico, Oroville, and Paradise each represent about 1 percent of county land. The remaining 1 percent of urban uses in the county is found in 15 smaller urban areas (Butte County 1996).

4.11.1.2 Project Vicinity Land Use

Similar to the larger region, most of the lands surrounding Lake Oroville consist of undeveloped forest, brush, and grazing lands. Within these areas are scattered pockets of development, including public marinas, camping, picnic areas, and other recreational facilities. The only area in proximity to the lake's edge subject to urban or suburban development is on Kelly Ridge, the peninsula that extends into the lake in the area east of the dam. Created in the 1970s, approximately 1,000 lots have been developed with single-family homes that provide year-round housing for a population that includes many retirees.

The lands surrounding the project area are primarily within the unincorporated portions of Butte County. Development within these areas is regulated by the 1979 Butte County General Plan and the Butte County Zoning Ordinance. Except for the Kelly Ridge area where small-lot residential development is permitted, land uses are generally restricted to agricultural and rural residential uses on large parcels.

At the north end of the lake, several small areas along the North and Middle Forks of the Feather River lie within the Plumas National Forest and are subject to the provisions of the Forest Plan that this Forest has adopted.

4.11.2 Land Ownership

Lands surrounding the project are primarily in public ownership and managed by the following entities: federal government (USFS and BLM), the state departments (DWR, DFG, and DPR), and Butte County. These entities, and their extent of land ownership in the project area, are described below.

4.11.2.1 Federal

USDA Forest Service

A small percentage of the project area is managed at the federal level. At the northern extremities of the project, the Middle and North Forks of the Feather River lie within the Plumas National Forest, managed by the USFS. In addition, the Big Bend portion of the North Fork is located within the Lassen National Forest, administered by the Plumas National Forest. The Plumas National Forest also manages the Feather Falls Scenic Area located on the outer extremity of the Middle Fork of the Feather River.

U.S. Bureau of Land Management

The BLM also manages a small portion of the project area. These BLM properties total approximately 6,500 to 7,000 acres, are located in a patchwork of parcels scattered among the extremities of the West Branch of the North Fork, the Middle Fork, and the

South Forks of the Feather River. One of the largest BLM holdings is Stringtown Mountain on the South Fork of the Feather River.

4.11.2.2 State

Department of Parks and Recreation

The vast majority of the project area is managed at the state level. The state DPR manages land in the project area that is primarily under fee title ownership by the DWR. The DPR manages the water surface area of Lake Oroville, as well as the majority of the shoreline areas. DPR-managed shoreline areas typically range from the waterline to approximately the 1,100-foot elevation. DPR-managed lands often exceed the 1,100-foot elevation in the major recreation areas such as Foreman Creek and Bidwell Canyon.

Department of Fish and Game

The DFG manages the Oroville Wildlife Area, east of the Thermalito Afterbay. The Oroville Wildlife Area is approximately 11,800 acres in size and stretches approximately 9.5 miles along the banks of the Feather River starting about two miles below the City of Oroville. Fishing, hunting, nature study, and river-associated recreation are the primary activities at the wildlife area. This area is managed with a cooperative agreement between the DFG and the DWR.

4.11.2.3 County

The majority of the project is within the unincorporated portions of Butte County. While the county owns no land within the project area itself, project-adjacent lands are subject to the provisions of the Butte County General Plan and Zoning Ordinance (see discussion below).

Private Ownership

While no privately owned lands exist within the project area, privately run marinas and campgrounds (concessionaires) are located along the project shoreline. These areas are leased from and managed by the DPR for commercial recreational purposes.

In addition, private residential developments in the unincorporated portions of Butte County, especially those along Kelly Ridge, are located above and to the east of Oroville Dam. Other county-managed private parcels exist on the upper elevations to the north of the lake. Similarly, private development within unincorporated areas of the county occurs around the Thermalito Afterbay.

4.11.3 Applicable Land Management Plans

The project area is primarily managed by seven land and resource management plans: (1) Recreation Plan for Lake Oroville State Recreation Area (DWR 1993); (2) Plumas National Forest Land and Resource Management Plan (PNF 1988); (3) Redding Resource Management Plan (BLM 1993); (4) Resource Management Plan and General Development Plan, Lake Oroville State Recreation Area (DPR 1973b); (5) Oroville Wildlife Management Area Management Plan (DFG 1978); (6) Butte County General Plan (1996); and (7) the City of Oroville General Plan (1995). These plans and their implementing polices as they relate to the project are described below.

4.11.3.1 Plumas National Forest Land and Resource Management Plan (LMRP) (1988, as amended)

Some of the lands at the North Fork, Middle Fork, and South Fork extremities of Lake Oroville are National Forest System lands that are part of the Plumas National Forest. In addition, in the Big Bend area defined by the large bend in the North Fork at the north end of the lake, there is an area of National Forest System lands that are a part of the Lassen National Forest but which are administered by the Plumas National Forest. The management policies for these lands were established by the Plumas National Forest Land and Resource Management Plan, adopted in 1988. In general, the policies for the lands in these areas emphasize resource conservation, provision of high quality recreational opportunities, and protection of visual resources.

The Forest System lands adjacent to the North Fork and South Fork arms of the reservoir have been designated with a Visual Retention management prescription, which carefully controls timber harvest and other development activities to maintain the landscape in a natural appearing condition. The Forest System lands adjacent to the Middle Fork end of the reservoir have been designated with a Recreation Area management prescription that has standards and guidelines for balancing recreational use with protection of environmental resources. In this area, no timber harvest is permitted.

The Middle Fork of the Feather River, from the point where it enters Lake Oroville, eastward to the area of its origin near Portola, was established as a Wild and Scenic River by Congress in 1968. The Forest Plan manages the National Forest System lands along this reach of the river for preservation of the river’s free-flowing condition and ecological and aesthetic value, and provides for a spectrum of recreational opportunities. Since 1965, a 15,000-acre area along the Middle Fork tip of the lake and extending several miles to the north and east along the Middle Fork of the Feather River and along Fall River has been designated as the Feather Falls Scenic Area. This area was established to protect this area's highly valued scenic features, which include Feather Falls, located on the Fall River one-half mile east of Lake Oroville. Feather Falls has a drop of 640 feet, sixth highest in the continental United States. Other scenic resources in this protected area include South Branch Falls, Curtain Falls, and Brush Creek Falls. This area is managed for recreation and protection of scenic values, and the Forest Plan's management prescription for this area provides that it be recommended for National Natural Landmark status.

The Plumas National Forest LRMP provides management direction, as well as standards and guidelines, for the upper reaches of Lake Oroville within the forest's French Creek Management Area and Galen Management Area. These management areas, and their standards and policies as they relate to Lake Oroville, are described below.

French Creek Management Area

The French Creek Management Area is located between the North Fork of the Feather River, the Pulga-Four Trees Road, and the Oroville-Quincy Road. This 29,892-acre management area is primarily within the watershed of French Creek, which flows into the North Fork of the Feather River within Lake Oroville. Table 4.11-1 lists the standards and guidelines for the French Creek Management Area, as applicable to the project.

Galen Management Area

The Galen Management Area extends easterly from Big Bend on the North Fork to the canyon of the Middle Fork of the Feather River. This 8,719-acre management area is bounded on the north by a segment of the North Fork Feather River and the Oroville-Quincy Road through the Brush Creek Work Center and on the south by the Forest boundary. Instability is a problem in the steep North Fork Canyon. Dispersed recreation is light because the area lacks recreational attractions and private land is widespread. Major activities include fishing, hunting, and some camping. No developed campgrounds are in the area. Table 4.11-2 lists the standards and guidelines for the Galen Management Area, as applicable to the project.

Table 4.11-1: Applicable Plumas National Forest Standards and Guidelines in the French Creek Management Area

General Direction	Standards and Guidelines
Recreation	
Efficiently manage recreation in the Lake Oroville State Recreation Area	Continue cooperation allowing the DPR to manage the reservoir area including Plumas National Forest lands.
Provide developed recreation facilities/programs to meet demand while reducing unit costs	Maintain Rogers Cow Camp Campground, but operate as a self-service facility with no developed water supply. Close when major expenditure is required.
Visual Resources	
Maintain pleasing visual corridors	Minimize the visual impact of transmission lines and hydroelectric facilities.
Wildlife	
Maintain species viability	Provide suitable bald eagle foraging habitat along the North Fork upstream from Lake Oroville.
Water	
Protect and where necessary, improve water quality	Maintain and construct additional erosion control works when needed to control excessive erosion and sedimentation from the French Creek basin.
Facilities	
Upgrade forest arterials and collectors	Reconstruct the Quincy-Oroville Highway as part of the Forest Highway System. Reconstruct the Stanwood Saddle Road in cooperation with Butte County.
Source: USFS (1988)	

Table 4.11-2: Applicable Plumas National Forest Standards and Guidelines in the Galen Management Area

General Direction	Standards and Guidelines
Recreation	
Efficiently manage recreation in the Lake Oroville State Recreation	Continue cooperation allowing DPR to manage the reservoir area including Plumas National Forest lands.
Provide for semi-primitive recreation	Maintain the character of the Big Bald Rock semi-primitive area. Restrict ORV use.
Facilities	
Provide roads necessary to meet developed recreation and other demands	Improve access to the Milsap Bar Campground on the North Fork Feather River.
Source: USFS (1988)	

4.11.3.2 Redding Resource Management Plan and Record of Decision (1993)

This resource management plan for the Redding Resource Area, was developed by the BLM in 1993. The project area falls within the BLM's Ishi Management Area. The land management objective for BLM properties that fall within the project area include the following:

> "Transfer via exchange or the Recreation and Public Purposes Act (R&PP) to the State of California all surface and submerged public lands encompassing approximately 6,400 acres within and adjacent to the Lake Oroville State Recreation Area. All lands identified by California or BLM as excess to park needs will be offered for exchange to any party after two years from approval of the Final RMP." Objective G (7)."

4.11.3.3 Resource Management Plan and General Development Plan, Lake Oroville State Recreation Area (1973)

This management plan for Lake Oroville State Recreation Area was developed by the DPR in 1973, and is still in use today. This plan describes allowable recreational uses and intensities for various areas around the lake, such as Bidwell Canyon, Lime Saddle, Goat Ranch, and others. Recreational intensities described in the plan are primarily tied to slope and resource protection constraints. The plan also describes the existing and proposed recreational development within 15 areas of the park, including Kelley Ridge, Bidwell Canyon, Loafer Creek, Spillway Launching Ramp, Lime Saddle, Thermalito Forebay, and other areas. These developments include overnight facilities (camping sites, group camps, cabins, and lodges), day-use facilities (parking, picnic units, and swimming beaches), and boating facilities (launching lanes, car/trailer parking, and marina slips).

The management policy statement contained within the plan is as follows:

> "The lands and resources at Lake Oroville State Recreation Area shall be managed so as to make an optimum contribution to the enjoyment of recreational opportunities and facilities in a natural or quasi-natural environment. Landscape values and vegetation elements shall be protected against scarring and degradation to the fullest practicable extent and shall be enhanced to improve the recreational environment whenever and wherever possible. Hunting may be permitted if time or space zoning can afford

> adequate safety. Cultural values shall either be adequately protected or fully recovered under professional direction."

The management plan also states that the purpose of Lake Oroville State Recreational Area is to:

> "…perpetuate, enhance, and make available to the public the recreational opportunities afforded by Lake Oroville, Thermalito Forebay, and adjacent land and water areas and to protect all environmental amenities so that they make an optimum contribution to public enjoyment of the area."

4.11.3.4 Recreation Plan for Lake Oroville State Recreation Area (1993)

The DWR Amended Recreation Plan (1993) for the LORSA superceded the 1966 plan, Bulletin 117-6, and was adopted by the FERC as the recreation plan for the LOSRA. This was done in compliance with the FERC Order of October 1, 1992. The 1993 plan describes the recent improvements (pre-1993 plan adoption) and the commitments of DWR to construct specific additional facilities and take specific actions to address the fisheries and recreation needs at LORSA deemed necessary by FERC. The plan also detailed the timeframe for the completion of the proposed projects. The DWR also acknowledged in the 1993 plan that, as the licensee, they were responsible for funding specific improvements. The 1993 plan describes the fish and wildlife resources, facilities, local area, user patterns, operation of the Oroville Complex, economic considerations, recreation plan, and the fisheries management plan.

This updated plan acknowledged that recreation activities and preferences had changed over time in terms of less demand for boat use and fishing, and increased demand for equestrian, bike, and hiking trails. Another finding was that use patterns at that time (1993) had changed somewhat due to low water levels, making some facilities inaccessible or unusable. The plan states many recommendations for facility expansion and modification in light of these findings. Many of these recommendations have since been implemented.

4.11.3.5 Oroville Wildlife Area Management Plan (1978)

In 1978, the DFG developed the management plan for the Oroville Wildlife Area. The purpose of the plan was to provide for the preservation and enhancement of the Oroville Wildlife Area and for the reasonable use and enjoyment by the public. In 1962, the

Director of Water Resources declared that public interest and necessity required the acquisition of the Oroville Borrow Area (the clay source for the construction of the Lake Oroville Dam) for fish and wildlife enhancement and recreation. On August 12, 1968, 5,500 acres was transferred to DFG for creation of the Oroville Wildlife Area.

The 1978 plan describes the purpose for the plan, description of the area, history of the site, present (1978) situation and problems, and recommended action programs. The plan states that one of the three primary objectives of the area is to provide for the recreational, scientific, and educational use of the area. However, the plan also states that destructive uses and activities incompatible with wildlife and fisheries objectives will be eliminated through enforcement of existing regulations or development of additional regulations if necessary.

4.11.3.6 Butte County General Plan (1996)

With exception of areas at the North Fork, Middle Fork, and South Fork extremities of the lake that come under the jurisdiction of the Plumas National Forest, the lands near Lake Oroville are subject to the provisions of the Butte County General Plan and Zoning Ordinance. The County General Plan and Zoning Ordinance also regulates land use and development that occurs in the unincorporated areas surrounding Oroville, where many of the project’s downstream facilities are located.

The Butte County General Plan contains 11 separate elements; each element sets forth the County's adopted goals, objectives, policies, and standards for various issues affecting Butte County. Together, these elements make up the Butte County General Plan. The Land Use Element was adopted in 1979, with revisions through January 2000.

The land use element of the Butte County General Plan designates the following land use categories within the project area: (1) Grazing and Open Land, and (2) Low Density Residential. These land uses, including their primary, secondary, and intensity of use, are described below.

Grazing and Open Land

Primary Uses: Livestock grazing, animal husbandry, intense animal uses and animal matter processing.

Secondary Uses: Resource extraction and processing, forestry, plant crops, agricultural support services, outdoor recreation facilities, airports, dwellings, utilities, environmental preservation activities, public and quasi-public uses and home occupations.

Intensity of Use: Minimum parcel size of 40 acres. Gross density could vary from 20 to 40 acres per dwelling unit provided at least 80% of the total acreage of a project is set aside for open space uses. One single-family dwelling per parcel with additional housing for on-site employees.

Low Density Residential

Primary Uses: Detached single-family dwellings at urban densities

Secondary Uses: Agricultural uses, animal husbandry, home occupations, outdoor recreation facilities, utilities, public and quasi-public uses, group quarters and care homes.

Intensity of Use: Zoning allows net parcel sizes of 1 acre to 6,500 square feet. One single-family dwelling per parcel with other residential uses limited to a maximum density of six dwelling units per gross acre. Home occupations, farm animals, other uses and setbacks regulated to maintain single-family residential character.

Butte County Land Use Policies

The Butte County General Plan contains a number of policies regarding the operation and management of Lake Oroville. The county's policies are primarily related to enhancement of recreational and biological resources at Lake Oroville, as well as the reduction of potential flood and seismic hazards. Butte County has indicated its strong interest in promoting more recreational development around the reservoir, and there appears to be support for land use and zoning designations around the reservoir that would make this development possible. The county policies relevant to Lake Oroville are described below in Table 4.11-3, organized by element of the General Plan.

Table 4.11-3: Butte County General Plan Policies Related to Lake Oroville

Element	Policy Statement
Land Use	Biological Habitat: Lake Oroville and the county's larger streams are highly valuable habitats for trout, salmon, bass, and other game fish. Several rare and/or endangered plants and animal species are found within the county. Policy 6.5.a. Regulate development in identified winter deer ranges to facilitate the survival of deer herds. Policy 6.5.b. Prevent development and site clearance other than river bank protection of marshes and significant riparian habitats. Policy 6.5.c. Limit development which would increase sediment loads in prime fishing waters. Policy 6.5.d. Regulate development to facilitate survival of identified rare or endangered plants and animals. Geologic Hazards: The risk of landslides is greatest in areas with steep slopes, weak rock, and high rainfall; some areas around Lake Oroville and its branches have very high risk. Erosion potential varies by the same factors but is greatest in granite areas. Findings and policies on these subjects and other geologic hazards are presented in the Safety Element adopted in 1977. Policy:7.4.a. Correlate allowable density of development to potential for landslides, erosion and other types of land instability.
Open Space	Open Space for Outdoor Recreation: The DPR manages the extensive recreation facilities around Lake Oroville and the Thermalito Bays. Policy L: The county should encourage the DPR to complete their development of recreational facilities in the Lake Oroville State Recreation Area.
Recreation	Policy 5: Lake Oroville and Facilities: Proposed development (parking, camp, picnic, boat ramp, comfort station, trailer, food, gasoline, oil, water, observation points and other facilities to serve the recreation minded public) at the following facilities: Lime Saddle, Foreman Creek, Bloomer, Craig, Kelly Ridge, Forebay, Loafer Creek, Goat Ranch, Afterbay, Potter Ravine, Fish Hatchery, etc. Development Agencies: County, Recreation District and State Department Parks and Recreation

Source: Butte County (1996)

4.11.3.7 City of Oroville General Plan (1995)

The City of Oroville General Plan, adopted in October 1995, is a statement of Oroville's long-term future, focusing on the physical components that describe the city. The plan contains a number of elements, such as land use, circulation, conservation, and safety. Included within every element are a set of objectives which represent the expressed desires of the city, and polices which represent the city's adopted commitments to implement those desires.

City of Oroville Land Use Designations

The Land Use Element of the City of Oroville General Plan designates areas near the project as “Medium Density Residential” and “Parks.” These land use designations are described below.

Medium Density Residential. Medium density residential land uses in the Oroville Planning Area consist of single-family residential development with approximately two to six units per gross acre on land under 30 percent slope. This land use is primarily found in the Kelley Ridge area of the Oroville Planning Area.

Parks. This land use category includes public parks, golf courses, or other appropriate uses. A recreational vehicle park or campground may be permitted within areas designated Parks as a conditional use permit. This land use in the project vicinity is primarily found near the Oroville Dam, and contains such recreational areas as the Bidwell Canyon Campground and the Lake Oroville Visitor Center, which are managed by the DPR.

City of Oroville Land Use Policies

The City of Oroville General Plan contains a number of policies regarding the operation and management of Lake Oroville. The city’s policies are primarily related to enhancement of recreational and biological resources at Lake Oroville, as well as the reduction of potential flood and seismic hazards. These policies relevant to Lake Oroville are described below in Table 4.11-4, organized by element of the General Plan.

4.11.4 Shoreline Development and Management

Shoreline development is managed by the DPR. State-run recreational areas on the Lake Oroville shoreline include the Lime Saddle Recreational Area, Nelson Bar, Vinton Gulch, Goat Ranch, Dark Canyon, Foreman Creek, and Craig Saddle. Other state-run shoreline recreational areas are located on the Thermalito Forebay. Privately run facilities (concessionaires) on the Lake Oroville shoreline include Bidwell Canyon Marina and Lime Saddle Marina.. All of these shoreline areas except those on the Afterbay are managed by the DPR in accordance with the Resource Management Plan and General Development Plan for the Lake Oroville State Recreation Area (1973b). This general development plan is still used for long-term planning purposes and shoreline management, as described in Section 4.11.3.

Table 4.11-4 City of Oroville General Plan Policies Related to Lake Oroville

Element	Policy Statement
City Design	Policy 4x: Request the state to landscape and develop the Thermalito Afterbay as a destination water recreation park which defines the western boundary of the community in accordance with the state's original mater plan of recreation development associated with the FERC permit. Policy 4y: Encourage the efforts of the Feather River Parks and Recreation Department in the North Forebay, Nelson Ballpark expansion, and the development of River Bend Park.
Open Space, Natural Resources and Conservation	Policy 6.11s: Coordinate with the DFG to ensure the ongoing operation of the Feather River Fish Hatchery. Policy 6.11w: Work with the DFG to ensure the preservation and enhancement of species or resident and anadromous fish along the Feather River, in Lake Oroville, and throughout the Planning Area.
Safety	Policy 8.10e: Monitor studies related to induced seismicity; if further studies establish a conclusive relationship between reservoir drawdown, refilling, and seismic activity, encourage the DWR to manage the Oroville Dam water regime to reduce risk (evidence thus far suggests a relationship between reservoir drawdown, refill, and subsequent seismic activity. This was seen in the 1975 Cleveland Hills earthquake, thought to have occurred after unprecedented drawdown and refilling of Lake Oroville). Policy 8.20m: Identify critical facilities in flood hazard areas and within the Oroville Dam inundation area, and seek ways to improve their level of protection, if possible (Critical facilities provide fire and emergency services, water, electricity, gas supply, sewage disposal, communications, and transportation). Policy 8.20o: In the event of dam failure on the Oroville Dam, implement emergency measures consistent with the city's Multi-hazard Functional Disaster Plan (Dam failure, while considered unlikely, is among the hazards mentioned in the City's Multi-hazard Functional Disaster Plan).
Source: City of Oroville (1995).	

4.12 AESTHETICS

4.12.1 Overview

Development of the Oroville Facilities in the 1957 to 1968 period represented a significant planning, engineering, and construction achievement, and the complex's scale and extent place it among the most ambitious U.S. water and hydroelectric projects. The project's dams, reservoirs, and related facilities are now among the most visually important elements of the Oroville area's landscape, affecting an area that extends over 20 miles from the Thermalito Afterbay, located southwest of the city, to the upper reaches of the Lake Oroville, located to the city's east and north.

The project facilities that lie to the east of Oroville all fall within the Sierra Nevada foothill landscape region, the transition zone between the flat lands of the Sacramento Valley floor and the steeply sloped, higher elevation lands of the Sierra Nevada. The foothills are characterized by moderately to steeply sloped ridges and deep, steep-sided canyons, and the vegetative cover is a mosaic of chaparral and forests of gray pine and blue oak. Although the scenery in the portion of the foothill region around the project's eastern facilities is attractive, most of it does not have a high level of vividness; as a consequence, it is generally of local and regional but not state or national importance. One portion of the foothill area near Lake Oroville with scenery of more note is an area north and east of the terminus of the Middle Fork arm of the reservoir that is a part of the Plumas National Forest. Here, the area along the Middle Fork upstream of the reservoir has been designated a Wild and Scenic River. In addition, this area is the site of several waterfalls, including Feather Falls on the Falls River. In *California Waterfalls* (Brown 1997), Feather Falls receives a rating of ten for its beauty, indicating that it has been judged to be among the 20 most beautiful waterfalls in the state.

The area to the north, west, and south of Oroville (where the Fish Barrier Dam and related fish facilities, the Thermalito facilities, the Oroville Wildlife Area, and the Low Flow Channel are all located) is in the Sacramento Valley landscape region. The valley landscape region encompasses the vast expanse of flat valley lands that extend over 140 miles in length from Lodi north to Red Bluff, and 40 to 50 miles in width from the Coastal Range foothills on the west to the Sierra Nevada foothills on the east. The visual character of the flat valley lands that lie around the project facilities is defined by a mix of agriculture and low density urbanization. The agricultural areas include lands used for irrigated row crops and orchards, and irrigated and unirrigated grazing. In many cases, the areas along the valley's rivers and streams are lined by riparian forests of tall trees and thick shrubs. An unusual feature of the valley landscape in the vicinity of the project consists of the large, gravel-like piles of tailings along the Feather River in the area south of Oroville that were created by the dredge mining that took place along the Feather River in the late 19th and early 20th centuries. The piles of tailings create areas of lumpy appearing low hills, like those found in the Oroville Wildlife Area. In general, the landscapes in the valley areas around the project facilities are of local significance.

Construction of the Oroville Facilities significantly altered some areas of the pre-existing landscape, most notably through the construction of the Oroville Dam in the Feather River Canyon, and the flooding of the canyon to create Lake Oroville. The valley lands west of Oroville have been altered through creation of the Forebay and Afterbay. Although construction of the project led to a loss of the scenic canyon areas flooded by Lake Oroville, the reservoir and a number of the project's other features have become points of aesthetic interest and local and regional landmarks in their own right. For example, views of Oroville Dam, the Oroville Dam spillway, Lake Oroville, and the Fish Barrier Dam and Fish Ladder are often featured on local postcards and in visitor brochures. The Bidwell Bar Bridge, the suspension bridge built at the time of the project's development to carry Highway 162 over the reservoir, has become a local scenic icon, and views of it are featured on postcards and in other local tourism-oriented media.

The aesthetic characteristics or the project's major features are briefly summarized in the next section. Refer to Section 2.0 for detailed descriptions of each of the features, plans, sections, and in some cases, oblique air views.

4.12.2 Visibility and Appearance of Project Facilities and Features

4.12.2.1 Oroville Dam, Spillway, and Edward Hyatt Powerplant

Oroville Dam is a massive earthfill structure that rises 770 feet above the floor of the Feather River Canyon, and which extends approximately 1.3 mile along its crest (Figure 2-3). The dam is the second highest in California, exceeded in height only by Shasta Dam. The most imposing views of Oroville Dam's gravel-covered face are those which can be obtained from Oroville Dam Boulevard in the portion of the canyon just west of the dam. Portions of the dam face can be glimpsed from areas farther west in the City of Oroville. From some areas along Highway 70 and areas to the west, the dam can be seen as a large rectangular feature on the face of the hills, whose horizontal lines and bare, light gray-brown surface contrast with the darker colors and more undulating lines of the forested foothill backdrop. Besides being a prominently visible element of the local landscape, the dam also serves as an important viewing platform. A paved two-lane road across the top of the dam accommodates vehicles and pedestrians and provides panoramic views west down the Feather River Canyon and across the Sacramento Valley, and east, across the expanse of the reservoir and toward the high, steep hills that frame the lake.

The dam's spillway, spillway control gates, and emergency spillway weir, which are located at the dam's north end, are visually important elements of the dam complex. The 178-foot wide concrete spillway chute, which extends for over 3,000 feet down the north slope of the canyon from the spillway headworks at the top of the slope to the plunge pool at the canyon bottom, is of particular visual prominence. The spillway's light concrete color and vertical lines contrast with the natural appearing canyon slope, making it highly visible in nearby views from the canyon. When the dam is overspilling, the flow of water down the spillway; the surging and mist created as the water strikes the massive chute block at the spillway's base, creating a spectacle that attracts viewers and media attention. Dramatic images of the spillway's turbulent waters and mists appear on local postcards and in local tourism literature. Over the past two decades, the number of spill events occurring per year has varied from none to five, and the spills have tended to last from a few days up to a week. In a few exceptional cases, the spills have extended for periods of over two weeks. Spillway flows have ranged from 1,000 cfs or less to a 137,000 cfs maximum flow, which occurred in 1988. During most spill events, the maximum flows fall in the range of 5,000 to 50,000 cfs.

Because the Edward Hyatt Powerplant is located in a cavern constructed underneath the reservoir, the powerplant itself is not visible in views of the area around the dam. However, several of the features that are ancillary to the powerplant have some degree of visibility. When the reservoir is drawn down, the two cylindrical intake structures are visible along the reservoir's bank just south of the dam. In addition, the powerplant's switching station, located in the canyon at the base of the dam, is visible in views from the top of the dam and from nearby areas of the canyon.

4.12.2.2 Lake Oroville

When Lake Oroville is filled to its maximum operating storage level at the 900-foot elevation, it covers 15,810 acres or nearly 25 square miles, and has a 167-mile shoreline. Besides being visible from the road and walkway along the crest of the dam, the reservoir is prominently visible from Highway 162 and the Bidwell Bar Bridge, to a lesser extent from Highway 70, and from a number of local roads that pass close to it. The reservoir is also visible from streets and homes in the Kelly Ridge residential area located on the ridge overlooking the Bidwell Canyon arm of the reservoir, and from a small number of residences scattered across other hillsides overlooking the lake. The Lake Oroville Visitor Center, located at the crest of Kelly Ridge, includes a 47-foot high observation tower designed to provide panoramic views of the dam and of the reservoir. Many of the most immediate views of the reservoir are from the marinas, boat launch areas, campgrounds, picnic areas, and other developed recreational areas surrounding the lake. Data presented in the Recreation analysis (Section 4.9) indicate that the recreation areas located around the edge of Lake Oroville receive over 700,000 visitor days per year, and that much of this recreational use is concentrated in the vicinity of the dam at the Spillway, Bidwell Canyon, and Loafer Creek recreational areas. The Lime Saddle recreation area on the upper West Branch arm of the lake is another area of concentrated recreational use.

Lake level is the critical variable affecting the aesthetic quality of views of the lake. When the lake is at or near its maximum operating storage level of 900 feet, it is at its most attractive. It is at this time that photographs used for lake postcards and tourist brochures tend to be taken that depict the lake's waters meeting fully vegetated shorelines. As drawdown occurs during the course of the summer and fall, an increasingly broad ring of shoreline appears in the area between the usual high water mark and the actual lake level. In some drawdown areas, usually those just below the average high water level, the aesthetic effects of drawdown are mitigated by groundcover, trees, and shrubs that are able to survive periodic inundations. In many areas along the lake, however, the bare red and gray soils that become exposed create a drawdown zone that contrasts vividly with the vegetated areas above the usual high water level and the water surface below. In narrow, steeply sided arms of the lake, large drawdowns can create conditions in which it appears that the lake is set within a deep, red-sided canyon. In areas where the slopes are gradual, areas that appear to be large reddish mudflats are created. Data on the fluctuations of the lake's levels are presented in Section 3.5, Reservoir Operations. As these data indicate, the reservoir usually reaches its highest level, which can vary between 800 and 900 feet, sometime between March and June. During July and August, the period of heaviest water demand, the lake level can drop significantly, but then stabilizes in the fall as water demand tapers off. The lowest water levels, which generally range between 700 and 800 feet, usually occur between November and January when the reservoir is drawn down to maximize flood storage in preparation for the spring flood season. In drought years, the reservoir has been drawn down to levels as low as 650 feet. As a consequence of the way the reservoir's water is managed, the reservoir's appearance tends to be very good in late spring and early summer when lake levels are high, but its attractiveness usually declines in July and August when the visually contrasting drawdown area expands significantly.

In general, the aesthetic integrity of the lands along the lake's shoreline is reasonably high. As indicated in the Land Use and Management Discussion (Section 4.11), most of the land surrounding Lake Oroville is owned by the DWR and is managed for watershed protection and recreation. Small areas around the lake are owned by the BLM and larger areas located along the Middle and North Forks of the Feather River at the reservoir's northern extremities are National Forest System lands within the Plumas and Lassen National Forests. None of the lands lying immediately adjacent to the lake are under private ownership. Because of the public ownership of the lands around the lake, the only development on the lake shore consists of recreational facilities operated by the DPR or by concessionaires. Aside from the recreational facilities, the hillsides surrounding the lake's edge have a natural-looking appearance characterized by a mix of areas of forest, brush, and grasslands. The USFS lands along the North Fork and South Fork arms of the reservoir have a Visual Retention management designation, which limits timber harvest and other development activities to maintain the landscape in a natural appearing condition. The USFS lands along the upper reaches of the Middle Fork arm of the reservoir have a Recreation Area management prescription that balances recreational use and protection of environmental resources. In addition, the portion of the Middle Fork of the Feather River upstream of the reservoir was nominated as a Wild and Scenic river by Congress in 1968, and is managed by the Plumas National Forest for preservation of the river's free-flowing conditions and ecological, aesthetic, and recreational values. The Plumas National Forest has designated a 15,000-acre area along the Middle Fork of the Feather River and the Fall River immediately upstream of the reservoir as the Feather Falls Scenic Area to protect Feather Falls and several additional waterfalls nearby.

4.12.2.3 Thermalito Diversion Dam and Pool

The Thermalito Diversion Pool consists of the stretch of the Feather River below Oroville Dam, which has been backed up Diversion Dam located 4.5 miles downstream to flood much of the canyon bottom. Cherokee Road flanks a small portion of the Diversion Pool's west side, providing views into the canyon and across the pool. The Diversion Pool is also visible from the hiking and bike trails that border it on both sides and from the equestrian trail along its southern edge. The pool has recently been opened to non-gasoline powered boats, so it is now also visible to boaters. The scenic values in the area along the Diversion Pool are high because of the visual interest provided by the high, steep canyon walls and, at times when spills are occurring, by views of the Spillway. The level of the Diversion Pool does not fluctuate much on a daily basis, but in the winter and spring when flooding events occur, the water levels can rise dramatically.

The Thermalito Diversion Dam is a 145-foot high, 625-foot long concrete gravity structure with a regulated ogee spillway (Figure 2-7). Visible elements of the dam complex include the Thermalito Power Canal, located on the dam's north side, and the Thermalito Diversion Dam Powerplant, located at the base of the dam's south abutment. The dam is visible from the trails on both sides of the river, from the picnic and boat launch area located just upstream of the dam, and from the observation area at the Fish Barrier Dam a short distance downstream. This dam's design is attractive, and the facility integrates well into its visual setting, but at most times of the year, it appears to receive relatively little attention as a point of local visual interest. During flood periods when there are flows over the dam, sightseers are attracted to the railroad overcrossing and Orange Avenue in Oroville, vantage points from which the flows can be readily observed.

4.12.2.4 Thermalito Forebay and Afterbay

Thermalito Forebay is a 630-acre reservoir just west of Highway 70 in the transition zone between the flat lands of the valley and the rolling and more steeply sloped lands of the foothills (Figure 2-11). The reservoir has an hourglass shape, consisting of two major segments, known as the North Forebay and South Forebay, which are connected by a narrow channel at Nelson Avenue. The reservoir is formed by a low earthfill dam (91 feet high at its highest) that extends for over three miles along the Forebay's southern edge. The Forebay is located 1.9 miles west of the Thermalito Diversion Dam and Pool, and is linked to them by the Thermalito Power Canal, a wide, concrete-lined channel. The Forebay is visible to travelers on Highway 70, bicyclists using the bike trail that travels around the northern edge of the North Forebay and the southern edge of the South Forebay. It is also visible to users of the elaborately developed picnic, swimming, boating, and fishing areas along the North Forebay and of the less intensively developed recreational areas along the South Forebay. As indicated by data provided in the Recreation analysis (Section 4.9), annual visitor use at the North Forebay is estimated to be nearly 94,000 visitor days per year, and at the South Forebay, over 32,000 visitor days. Because the land around the Forebay's shoreline is owned by the DWR, the Forebay's edges are free of private development. In views north across the Forebay, the reservoir is framed by gently rolling grassland. At the northeast corner of the North Forebay, the irrigated lawns and dense groves of mature trees in the North Forebay recreation area create a green oasis that contrasts with the surrounding open grasslands. In views south across the Forebay, the top of the dam embankment is the most visually salient feature, and the tops of trees located on the flat valley lands lying below the dam are visible above the embankment. From the area of grazing lands and scattered rural residential development located on the flat valley lands immediately to the south of the Forebay, the Forebay embankment is visible as a low, grass-covered slope and appears to cause relatively little disruption in the overall landscape pattern.

Because the Diversion Pool, Power Canal, and Forebay are all designed to share the same operating water level, the water levels in each of these facilities rise and subside in unison. The Forebay does not fluctuate much on a daily basis, but during the summer, it is cycled down 2-4 feet during the middle of the week and then refilled to refresh the swimming lagoon at the North Forebay Recreation Area.

The Thermalito Pumping-Generation Plant located at the western end of the Thermalito Forebay is not particularly visible from publicly accessible areas. There are no formally developed viewing areas, and the closest views are those obtained from the undeveloped western end of the South Forebay recreation area. The plant appears as a low concrete dam structure, below which there is a concrete platform on which electrical transformers and a long, windowless rectangular structure containing the generators are located. The plant's scale form, and colors relate well to their surroundings, and the plant does not appear to be the source of visual problems.

The Thermalito Afterbay is a 4,300-acre (6.7 square mile) reservoir located 1.5 mile southwest of the Thermalito Pumping-Generation Plant, 4.5 miles west of central Oroville, and immediately east of State Highway 99 (Figure 2-15). The reservoir is formed by a low earthfill dam with a maximum height of no more than 39 feet which extends for nearly eight miles along the impoundment's western and southern edges. The edges of the reservoir formed by the dam have generally straight lines and a highly artificial appearance. On the north and east, the reservoir's edge is defined by the surrounding gently rolling terrain, which creates a more natural appearing shoreline in this area. The surface of the Afterbay is most visible from Highway 162, from the segment of Larkin Road located on top of the dam near the outlet structure, from the bike trail that passes along the top of the dam along the Afterbay's western and southern edges, and from the recreation areas along the Afterbay's northern and eastern shores. The newly developed Monument Hill recreation area located on the east side of the Afterbay at Highway 162, which features facilities for boating, fishing, and picnicking, is the most heavily used area along the shores of the Afterbay, with over 32,000 visitor days per year. The boating and fishing facilities at the Larkin Road recreation area located at the Afterbay's southeastern corner generate nearly 29,000 visitor days per year. The Afterbay's vast expanses of water create a source of visual interest. However, because much of the Afterbay's shoreline has an artificial appearance and because the lands surrounding the reservoir are generally flat, it is fair to say that the Afterbay is a scenic feature of primarily local importance. The levels of the Afterbay Reservoir can cycle about ten feet up or down as a function of the power generation and pump-back programs. At most times, the daily fluctuation is in the range of two to three feet per day. Annually, from March 1 through June 30, the reservoir is cycled up to near maximum to ensure that the duck ponds stay full, and to discourage ducks from nesting in the lower areas of the reservoir where their nests would be flooded with the next cycling of the reservoir.

4.12.2.5 Fish Facilities Area and Low Flow Section of the Feather River

The project's primary fish-related facilities are located along the Feather River approximately 0.6 mile downstream of the Thermalito Diversion Dam (Figure 2-17). The Fish Barrier Dam is a 91-foot high concrete gravity dam with a crest 600 feet long. The dam has an overpour crest, which creates a solid curtain of water along the dam face, which spills into the natural river channel at the base of the dam. At the north end of the dam is a fish attraction channel which leads fish migrating upstream into a concrete fish ladder that steps up the bank slopes and along the top of the bank for about 0.4 mile until reaching the hatchery complex. The fish facilities area is visible to some degree from the Table Mountain Boulevard bridge across the Feather River, but the most important views are from the visitor areas that are a part of this complex. On the north bank of the river, east of Table Mountain Boulevard, is a park-like visitor area with a landscaped parking lot, restrooms, and observation platform overlooking the Fish Barrier Dam and its curtain of water. This area also features an area with windows into the fish ladder that make it possible to observe fish as they swim up the ladder. On the west side of Table Mountain Boulevard is an additional parking area and pedestrian access to the hatchery complex, where visitor observation areas have been established that provide views of the fish ladder, the gathering and holding tanks, and the interior of the hatchery spawning building. In general, the structures and visitor use areas in the fish facilities complex are well designed and have a harmonious relationship with their setting. Images of the Fish Barrier Dam and its viewing platform and the fish ladder observation area appear on local postcards and in local tourism literature. High flow events attract considerable levels of visitation at the Fish Barrier Dam. When flows reach 30,000 cfs, the railing on the observation deck is removed and the public is restricted to the parking lot area.

The approximately 8-mile long reach of the Feather River between the base of the Fish Diversion Dam and the outlet of the Thermalito Afterbay is commonly referred to as the river's Low Flow Channel. Because much of the Feather River's water now flows through the Forebay and Afterbay, flows in this reach of the river are generally lower than they were before development of the project. The river's Low Flow Channel is most prominently visible at the points where Table Mountain Boulevard, Highway 70, and Oro Dam Boulevard West cross the river, from the bike and pedestrian paths in the Feather River Parkway adjacent to downtown Oroville, from undeveloped Riverbend Park, and from the Oroville Wildlife Area. To ensure the passage of migrating fish up to the Fish Barrier Dam, a minimum flow of 600 cfs is maintained in the Low Flow Channel at all times, and this flow sufficiently fills the river channel to create natural appearing conditions. It is important to note that the 600 cfs flow is a minimum; there are times when the flow is higher, providing a range of visual conditions in the channel. During flood events, flows can reach as high as 150,000 cfs, although flood flows of 30,000 to 40,000 cfs are more common.

5.0 RESOURCE ISSUES AND CURRENT AND PROPOSED STUDIES

5.1 INTRODUCTION

There are a number of ongoing studies initiated prior to relicensing. In addition to completing these studies, DWR proposes to conduct studies to evaluate the effects of the project on environmental resources. The studies should also meet the FERC licensing requirements of Exhibit E (18 CFR 4.51). This section presents ongoing studies and DWR's proposed approach to evaluation of existing project operation and identification of resource-specific issues and appropriate measures to address them. Current study plans will be discussed in the Work Groups and modified as needed to meet licensing objectives. Detailed study plans will be developed for relicensing issues raised through Work Group and plenary meetings. Proposed studies presented in this section are therefore preliminary and based on information obtained and issues identified to date.

5.2 WATER QUALITY

The DWR has been monitoring temperature changes in the Feather River, the Thermalito Afterbay, and the Thermalito Forebay. A river temperature model developed by UC Davis has been completed that will provide Oroville Project operators with more information on how specific water releases will affect temperatures throughout the Lower river and the likely impact of the temperature on river fisheries, recreation, agricultural diverters and the hatchery operations.

5.3 AQUATIC RESOURCES

5.3.1 Issues Associated with Hatchery Operation

There are several issues associated with operation of the Feather River Fish Hatchery. These issues will be explored further as DWR goes through the FERC relicensing process and are being addressed by existing discussions between DFG and NMFS. Some of the more significant issues needing resolution include:

- The degree to which mitigation-hatcheries add to the restoration of a natural ecosystem.
- The degree to which planting production fish, and experimental releases, outside the Feather River basin may have lead to increased straying and associated genetic impacts.

- The degree to which overlap in spawning and hatchery practices may have lead to interbreeding between the two runs and some loss of genetic fitness. The dam caused the spring and fall runs to spawn in about the same geographic area and about the same time. They were formerly geographically isolated, with the spring-run spawning high in the watershed and fall-run spawning near the foothills.
- The degree to which salmon production from the Feather River and other hatcheries may have allowed high ocean harvest rates – harvest rates that could not be sustained by natural runs.
- The degree to which the reservoir stocking plan should be adjusted due to the finding of a serious salmon disease, IHN, in Lake Oroville. There is concern that planting Feather River Fish Hatchery salmon in the reservoir may exacerbate disease problems in the hatchery. In 2000, there was a severe IHN outbreak at the hatchery, resulting in the loss of several million juvenile chinook salmon.

5.3.2 Lower Feather River Issues and Current Studies

5.3.2.1 Steelhead Snorkel Surveys and Habitat Inventory

In 1999, the DWR focused on determining where juvenile steelhead rear and on determining their relative abundance above and below the Thermalito Afterbay Outlet. Additionally, the DWR identified the types of habitat that juvenile steelhead prefer and their relative availability within the river. Side (secondary) channels within the Low Flow Channel were identified as high density rearing areas. Research on juvenile steelhead rearing will continue in 2001.

Snorkel surveys are also being conducted to monitor adult steelhead in the river. The goals are to identify migration timing, identify the number of naturally spawning fish in the population, and locate preferred spawning grounds. Preliminary information suggests that there may be two separate runs of steelhead in the Feather River, one in the winter and one in the spring/summer.

As part of our steelhead and salmon studies, the Geographic Information Center at Chico State mapped the riparian vegetation of the Feather River. This provides a general overview of the status of the riparian forest but does not provide the small-scale data needed to determine what type of cover is available for steelhead. Therefore, we are mapping the river's microhabitats to quantify the amount and quality of riparian habitat available for juvenile steelhead rearing.

5.3.2.2 Beach Seine Surveys

Beach seine surveys will continue to be conducted monthly to determine the temporal and spatial rearing extent of juvenile steelhead and salmon. Survey sites range from Hatchery Ditch to Boyd Pump boat ramp. Beach seine surveys indicate that a small number of salmon (5,000-15,000) remain in the river throughout the summer and probably migrate in the fall. Beach seining also reveals that few steelhead rear for any length of time below the Thermalito Afterbay Outlet.

5.3.2.3 Rotary Screw Trap Sampling, Fyke Sampling, Hatchery and In-Channel Coded Wired Tagging

Rotary screw fish traps will continue to be placed at two locations in the Feather River to monitor the timing and number of chinook salmon emigrants (see Figure 4.5.4-1). As a component of screw trap sampling, we will continue to tag naturally produced fall-run chinook salmon with a coded wire tag to determine their return success compared to hatchery releases. As fish return over the next several years, we will analyze these data. The DWR tagged approximately 65,000 juvenile salmon in 1998, 135,000 in 1999, and 150,000 in 2000. The DWR expects to tag approximately 150,000 to 200,000 juvenile salmon in 2001.

The DWR has also investigated the production of juvenile salmon and steelhead from a small side channel called Hatchery Ditch. In the 1999/2000 emigration period, the DWR trapped approximately 94,000 juvenile fall chinook in Hatchery Ditch. Trapping will continue throughout the 2000/2001 emigration period.

5.3.2.4 Egg Survival Studies, Spawning Aerial Surveys

Spawning aerial photographs, along with in-channel egg survival studies, provide information on the amount of habitat used for spawning and the relative egg survival at different river reaches. Egg survival studies conducted by the DWR in 1998 and 1999 revealed that survival is reduced as salmon move upstream (Kindopp 1999). The main cause for the reduction in survival may be egg superimposition caused by the large number of adults crowding into the Low Flow Channel. The number of spawning chinook salmon (in most years) greatly exceeds the amount of habitat available. For example, 1999/2000 emigration data from Hatchery Ditch (a small side channel in the LFC) reveal that the actual survival from egg deposition to emergence from the gravel may only be between five and 15 percent (DWR unpublished data). Egg superimposition is clearly reducing survival due to the high number of adult spawners in such a small area (approximately 2,000 female and 1,300 male fall-run chinook were estimated to have died in Hatchery Ditch in 1999, while only 1,000 females actually spawned).

5.3.2.5 Spawning Escapement Surveys

Past chinook adult escapement (carcass) surveys have been conducted by DFG. Estimates of the spawning run range from a low of 10,000 in 1979 to a high of 86,000 in 1955. When compared to pre-project (Oroville Dam) estimates, the 1969-1989 period is somewhat stable. Pre-Oroville Dam estimates ranged from roughly 10,000 salmon in 1953 to 86,000 in 1955 (DWR 1992). The stability seen post Oroville Dam is likely due to hatchery influence. Pre-1967, all chinook salmon in the Feather River spawned in the river. Estimates for the number of wild chinook spawning in the Feather River since project construction are not available. Escapement estimates of adult chinook since project completion have included both wild and hatchery salmon that spawned in the river. As coded wire tag data are recovered over the next several years, more information will be gained on the number of wild chinook spawning in the Feather River. The DWR and DFG are working to refine adult chinook escapement estimates.

5.3.2.6 Redd De-Watering and Juvenile Stranding Surveys

Because the Oroville Dam-Thermalito Complex often varies flows for water operations and Delta requirements, there is concern about the impacts this may have on redd de-watering and juvenile stranding. Each year on October 15, the flows in the Lower Reach of the Feather River (below Thermalito Afterbay) are reduced, dewatering some redds. Recent studies conducted by the DWR demonstrate two very important points: (1) the great majority of fall-run chinook spawn in the Low Flow Section of the river and are therefore not subjected to redd-de-watering; and (2) some redd de-watering does occur in the Lower Reach but is very small when compared to total run size (approximately 0.3-1 percent of the redds are de-watered, depending on the number of spawners in any given year and the timing of spawning).

Additionally, juvenile stranding (in off-channel ponds) can occur during high flow events and even during normal operations. Some stranding has occurred within normal river operations but is typically associated with higher flow events (>25,000 cfs). The DWR has substantially increased its effort to evaluate both juvenile stranding and redd de-watering. The DWR will also revisit the ramping criteria (how fast the flows are reduced at the Thermalito Afterbay Outlet) to determine the benefit of adjusting it to allow juveniles to move out of potential stranding areas as flows are dropped.

5.3.2.7 Steelhead Self Creel Surveys

The DWR is currently working with several local anglers to gather more detailed information on the life history of adult steelhead in the Feather River. Data collection includes the size of fish caught, whether the fish are wild or of hatchery origin, general coloration, and whether the fish are kept or released. There may be two runs of steelhead in the Feather River, but more data are needed to assess this. Angler surveys will continue in 2001.

5.3.2.8 Invertebrate Research

To learn more about what may be limiting to juvenile steelhead in the lower Feather River, the DWR, in cooperation with California State University, Chico, is conducting an invertebrate study. There are three main goals of this study: (1) to determine if there are differences in the invertebrate populations above and below the Thermalito Afterbay Outlet; (2) to determine if there are differences in invertebrate populations between the main channels and nearby side (secondary) channels; and (3) to examine stomach contents of juvenile salmon and steelhead to determine their diet preferences. This work began in June 2000 and will continue until June 2002.

5.4 TERRESTRIAL RESOURCES

DWR anticipates that additional information will be collected in the following terrestrial resource areas:

- Information on sensitive species occurrence and distribution within the project area;
- Information to develop a vegetation/habitat map for the project area; and
- Information on recreational wildlife use within the Oroville Wildlife Area and State Parks lands.

5.5 CULTURAL RESOURCES

Under Section 106 of the National Historic Preservation Act (NHPA) and FERC regulations, the relicensing applicant (DWR) is required to inventory archaeological, historical, and traditional cultural resources; evaluate their eligibility for listing in the

National Register of Historic Places (NRHP); describe project impacts to any such historic properties; and implement measures to avoid, minimize, or mitigate the project impacts to those properties. This work will be conducted in consultation with the cultural resource oversight agencies, State Historic Preservation Office (SHPO), and the National Park Service; federal and state land management agencies (including the USFS, BLM, and DPR); Indian Tribes and groups; and other concerned stakeholders.

DWR plans to document the Oroville Facilities (e.g., dam, powerhouse, etc.) to determine if they are eligible for listing on the NRHP. Given their important contribution to the historic, social, and economic development of the state, it can be anticipated that the research results will indicate that the Oroville Facilities represent the significant historical and cultural values that warrant nomination to the NRHP.

One of the primary goals of the cultural resources program is to provide FERC with an inventory of archaeological, historical, and traditional sites that will be affected by direct and indirect impacts of project operations. Focus areas for cultural resources surveys are expected to include reservoir operation shoreline fluctuation and boat wake zones, recreation areas, and project facilities and areas that may be affected by construction, operation, and maintenance such as transmission corridors and access roads.

The Stage I Survey is expected to include a review of the pertinent archaeological, historical, and ethnographic literature; analysis of the locales of project facilities and recreation areas; and field visits to identify impact areas and to assess their potential for containing sites. The results of the Stage I Survey will determine the type of Stage II work to be conducted.

The Stage II Survey may include a comprehensive on-foot inventory of impact areas that have a reasonable possibility for containing sites. This study phase may also include any additional field investigations, such as subsurface testing necessary to determine resource eligibility to the NRHP. Detailed descriptions of project impacts to National Register eligible sites may be an important component of this study phase.

The ultimate objective of the cultural resources program is to develop a detailed, consensus-based Cultural Resources Management Plan that provides measures for avoiding or mitigating impacts to significant sites due to project operation or new development.

5.6 RECREATIONAL RESOURCES

FERC requires that licensees develop a recreation plan that addresses existing and future public recreation needs associated with the project through the term of the new license. DWR proposes to develop this plan through the Recreation Work Group.

To develop this plan, several sequential tasks would be involved to address important project issues and satisfy relicensing participant concerns. Though not a comprehensive or final list, this effort would typically include the following studies.

5.6.1 Recreation Supply Analysis

The recreation supply analysis would describe existing recreation resources in the study area. This information would be used, along with other studies, to determine if these resources need to be better maintained, improved, or expanded based on an analysis of their current and anticipated future condition.

5.6.2 Recreation Surveys

Recreation surveys would be used to elicit responses from respondents about recreation opportunities at Lake Oroville. These data would be used to assess existing demand and use levels, assess visitor attitudes and preferences, and develop protection and enhancement measures.

5.6.3 Recreation Demand Analysis

This analysis would compile and estimate existing and future visitor demand for recreation opportunities and resources within the study area. The results of the recreation surveys, along with a regional recreation demand analysis, would be used to present recreation demand in the study

5.6.4 Recreation Capacity and Suitability Analysis

This analysis would investigate the existing capacity of recreation resources and determine whether recreation enhancements and activities are suitable in the study area while maintaining the integrity of the resources and meeting the long-term needs of visitors.

5.6.5 Recreation Needs Analysis

The recreation needs analysis would identify and project existing and future recreation needs in the study area. Results would be used to analyze the potential effects of hydropower development and operations on recreation resources and to develop protection and enhancement measures based on these needs.

5.6.6 Recreation Resources Management Plan

The Recreation Resources Management Plan (RRMP) would be developed based on the recreation needs analysis and balancing of other resources and project objectives. The RRMP would clearly identify DWR recreation resource responsibilities and phased costs over the term of the new license.

5.7 SOCIOECONOMICS

5.7.1 Issues

Perhaps the key socioeconomic issue for project relicensing is understanding how existing and potential changes in recreation activity associated with use of the LOSRA affects the local and regional economy, including businesses and local governments. This issue involves defining key socioeconomic relationships, including how existing recreation facilities and improvements, access, and water and fishery conditions affect recreation use levels, as well as how recreation use levels, in turn, affect visitor spending, employment, personal income, and tax revenues in the local and regional economy. A comprehensive understanding of these relationships may allow for evaluating the socioeconomic impacts of different operating and facility development scenarios, and for developing effective strategies to enhance economic development in the region.

A secondary socioeconomic issue pertains to potential economic benefits from using water stored at Lake Oroville for local municipal, industrial and agricultural purposes. This issue involves identifying potential institutional and legal constraints on local use of water stored at Lake Oroville, as well as evaluating the economic value of potentially using stored water for these purposes.

5.7.2 Studies

To address recreation-related socioeconomic issues, several baseline studies are anticipated. Historical and current conditions related to recreation and tourism activity in the region would be documented. Historical data on visitation to the LOSRA would be compiled and evaluated to identify important use trends. These data would be supplemented with additional recreation use information that provides details on where and when recreation use occurs at the LOSRA, the distribution of use by activity, and user characteristics.

Considerable information was collected in user surveys conducted by California State University, Chico in 1996; however, because of concerns about the validity of the information collected, the methods and data would be closely reviewed and evaluated. It is likely that new recreation user surveys may be needed to obtain information not collected in the 1996 surveys, such as more detailed information on visitor spending, patterns and contingent use questions (i.e., how would visitation change if improvements were made to recreation facilities or if water and fishery conditions were enhanced?). As a consequence, additional survey data on visitation, spending, and visitor opinions about facility conditions and improvements may also be collected to validate and/or supplement data collected in the 1996 user surveys.

In addition to visitor surveys, local businesses that provide goods and services to visitors to the LOSRA may be surveyed to identify important purchasing patterns and labor characteristics. This information will help to better understand the impact on the local and regional economy associated with potential increases in recreation use levels. Data derived from business surveys are very useful in evaluating impacts at the local level because "off-the-shelf" economic impact models (e.g., IMPLAN) consider effects only at the county or multi-county level.

Lastly, data may be collected from local government (i.e., cities, counties, unincorporated communities, and special districts) to better understand the fiscal implications of recreation activity at the LOSRA. Procedures for collecting and distributing tax revenues (e.g., sales taxes, lodging taxes, property taxes, and business taxes) generated by visitors to the Lake Oroville and by residents may be documented. Local revenue and public service officials may be interviewed to identify the mechanisms used to collect and redistribute tax revenue.

5.8 LAND MANAGEMENT

5.8.1 Issues

The primary issues affecting project lands adjacent to Lake Oroville are related to the expressed desires of local governments, businesses, and residents for more development of visitor-attracting recreational facilities that capitalize on the recreational potential of Lake Oroville. While primarily a recreational issue, there is a land management component in terms of the compatibility of potential new recreational development with adjacent land uses. The potential for land use conflicts, as well as opportunities, are present surrounding Lake Oroville.

Below Lake Oroville, the potential land use issue concerns the relationships between the Feather River, Feather River Fish Hatchery, Thermalito Canal, Forebay, Afterbay, and related power generation and recreational facilities with adjacent land uses in the City of Oroville and the surrounding unincorporated portions of Butte County on the city's fringes.

For example, Oroville residents have expressed the desire to improve the amenity value of the portion of the Feather River bypass reach that flows through the city. The community is looking for funds to improve the now largely undeveloped lands at Riverbend Park. In downtown Oroville, there has been a recognition of the potential to use urban design measures to open up views toward the river and to make it more of a focus and positive attraction to the city center. Land use compatibility and opportunities for coordination with the City of Oroville and Butte County are land management issues in the project area.

Other issues include the land use compatibility between new single-family residential development around the Thermalito Afterbay and the adjacent Oroville Wildlife Area. Public access, exotic weeds, and mosquitoes are issues that will likely arise as additional development in these areas is permitted by the county.

Finally, there is an issue of rightful land ownership between the state and local Native Americans in the project area. The Spencer Cemetery, located on state lands within the Craig Saddle area, has been a used for Native American and non-Native American burials in the past. This area is also considered a culturally significant, sacred place by local Native Americans. While the state currently manages this area and is aware of its cultural significance, Native American groups would like the cemetery returned to the local tribal government for their ownership and management.

5.8.2 Studies

To address land management issues, several baseline land use studies may be conducted. The studies would begin with an inventory of existing land uses in the project area beginning with a review of land use maps developed by Butte County, the USFS, DWR, and other government agencies; a review of aerial photography; and a field visit. Existing land uses would be placed into categories, including but not limited to: industrial/project facilities, recreation (including two to three subcategories), undeveloped open space, residential, commercial, and transportation (roads, trails, parking lots). These areas would be mapped and quantified using available geographic information system (GIS) coverages. Vegetation cover type mapping may also be utilized to identify and quantify developed/undeveloped lands.

Another study could include an identification and description of existing land use agencies with jurisdiction, applicable regulations, and management plans. Land management areas, jurisdictions, and ownership would be mapped and quantified using GIS, and then described. These would include areas owned and managed by DPR, DFG, USFS, BLM, Butte County, and the City of Oroville. A descriptive summary of zoning, other regulations, and comprehensive management plans and policies with study area coverages would be developed from a review of these federal, state, and local regulations and comprehensive management plans. These land use plans may include, but are not limited to, the following:

- Recreation Plan for Lake Oroville State Recreation Area, (DWR)
- Plumas National Forest Land and Resource Management Plan (USFS)
- Redding Resource Management Plan and Record of Decision (BLM)
- Resource Management Plan and General Development Plan, Lake Oroville State Recreation Area, 1973 (DPR)
- Oroville Wildlife Area Management Plan, 1978 (DFG)
- Butte County General Plan
- City of Oroville General Plan and Land Use Maps

Another study could include a review and summary of the project area’s natural and sensitive resources, including wetlands and floodplains information, sensitive biological habitats, and prime and unique farmlands which may act as land use constraints to future development. For this task, coordination with the biological resource studies would take place. These areas would be mapped in GIS.

The land use study would also coordinate with any recreational resources studies, specifically, the Shoreline Management Plan (SMP). Compatibility between future shoreline development and adjacent land uses would be summarized. The land use study would also coordinate with the cultural resource studies to identify land use and ownership as related to the Spencer Cemetery in the Craig Saddle area.

A matrix could be developed that compares land use compatibility in terms of high, medium, and low compatibility for both exiting development as well as recommended new improvements. Incompatible land uses (low compatibility) or areas of conflict would be further described and mapped as necessary to highlight this key land use issue. The potential effects of proposed land use changes as a result of the project could also be evaluated.

5.9 AESTHETICS

5.9.1 Issues

An important aesthetic issue for project relicensing is the need to address the phenomenon of highly contrasting areas of exposed shoreline that accompany reservoir drawdowns. A better understanding is needed of the extent and ways in which the exposed shoreline areas created by drawdown affect the perceptions of visitors and their aesthetic enjoyment of the project environment. Related issues important to understand include the impacts of the aesthetic effects created by drawdowns on recreational activities and levels of project area visitation. With the increasing attention that the City of Oroville is paying to the amenity values of the areas along the Low Flow Section of the Feather River, the maintenance of aesthetic flows in this reach of the river may also be a concern.

In general, project facilities are well designed and well maintained and do not appear to be a source of major aesthetic issues. However, there may be some specific areas with localized visual issues and concerns that can potentially be addressed by landscape treatment or other enhancements. For example, the City of Oroville and Butte County have been paying increasing attention to the developed and developing areas in the vicinity of the Feather River Low Flow Section, the Fish Hatchery, Thermalito Canal, Thermalito Forebay and Thermalito Afterbay; in addition, interest has been expressed in landscape improvements in these areas. A specific case in point is the area that lies to the south of the Thermalito Forebay where there has been increasing residential development. In this area, there may be a rationale for landscape improvements along some edges of the facility. Desires have been expressed for more landscape improvements at recreational facilities around the Thermalito Afterbay, similar to those that have been made at the Monument Hill Recreation Area. Concerns have been also expressed about the need to improve the appearance of project-related transmission lines. Given the more general interest in increasing levels of visitation at the project and visitor spending in the project vicinity, it may be desirable to identify opportunities to enhance the appearance of existing project recreational and visitor facilities and to identify opportunities to highlight and improve the accessibility and amenities of aesthetic resources that may now be under appreciated. In addition, to the extent to which additional recreational facilities are planned, there would be a need to select their sites and design them in a way that takes advantage of the project area's scenic assets and minimizes any negative impacts on them.

5.9.2 Analyses of the Aesthetic Consequences of Variations in Reservoir Levels and Streamflow

To address the aesthetic issues associated with variations in reservoir levels and in flows in the Low Flow Section of the Feather River, it may be appropriate to undertake studies to:

- Provide a basis for understanding the aesthetic consequences of variations in reservoir levels, the degree to which these fluctuations are a source of aesthetic concerns to the public, and the public's aesthetic evaluations of varying water levels;

- Identify any specific segments of the Low Flow Section that may be visually important and visually significant, assess the aesthetic consequences of variations in stream flows in the critical segments, identify the degree to which these variations in stream flow are a source of aesthetic concern to the public, and assess the public's aesthetic evaluations of the varying flows; and

- Provide a basis for identifying reasonable and cost-effective lake level and streamflow management and shoreline and drawdown area vegetation management measures that enhance project area aesthetics while meeting other project power production and resource management objectives.

Analyses of the aesthetic effects of fluctuating water levels in project reservoirs and varying flows in the Feather River Low Flow Section need to be conducted following a systematic approach that:

- Documents the frequency and timing of varying reservoir levels and streamflows;
- Uses still photography and videotaping to document reservoir and stream appearance from sensitive viewing areas at varying water levels and flows; and
- To the extent required, uses a variety of social science research techniques to establish the public's evaluation of the aesthetic quality and aesthetic acceptability of the varying reservoir levels and flows.

Establishment of the public's perceptions of the varying reservoir levels and streamflows could include focus groups and surveys. The focus group sessions could include small groups of people from the Oroville area and from the larger region from which project visitors are drawn. The goal of these sessions would be to develop an in-depth understanding of how visitors use, experience, and evaluate the recreational and aesthetic qualities of the project and its setting. The sessions could include a mix of facilitated discussions and photo sorting exercises. The insights generated by the focus group sessions could be applied to develop aesthetic items to be used in special surveys of visitor aesthetic preferences and in aesthetic-related items in the visitor surveys.

The surveys could include items that ask respondents to evaluate the aesthetic qualities and acceptability of the reservoirs at varying water levels and the Low Flow Section at varying flows. The value of the focus group sessions is that they could help identify issues and concerns of interest to the general public, as well as develop survey items structured and worded in a way to be consistent with public perceptions related to the issues.

5.9.3 Analyses of the Project's Relationship to the Project Area Landscape

The need for studies of the project area's landscape and aesthetic setting, and of the relationship of the project's elements to it, is driven in part by FERC's requirements that the Exhibit E describe measures that the applicant is proposing "…to ensure that any proposed project works, rights-of-way, access roads, and other topographic alterations blend, to the extent possible, with the surrounding environment" (18 CFR Ch.1, 4.51 (f) (6) (ii).

To meet FERC's requirements and provide a basis for identifying project aesthetic enhancements, it may be appropriate to undertake studies that would:

- Develop a baseline description of landscape and aesthetic conditions in the project area to provide a context for considering the project's implications for the aesthetic character and quality of its setting, and to provide a database that can be drawn on in identifying optimal sites for any additional visitor facilities.

- Assess the extent to which project facilities are visible, are located in visually sensitive areas, fail to "blend" with the surroundings, and create aesthetic problems that of concern to the public.

- Identify and evaluate mitigation measures that would be cost-effective in either ameliorating the appearance of any project features found to inadequately blend with their surroundings or to enhance the aesthetic experience of visitors.

The methods that could be used in implementing these studies could include:

- Mapping of the project area's landscape units and assessment of the visual character and quality of those landscapes, applying the principles of the newly adopted United States Forest Service Scenery Management System (SMS) (US Department of Agriculture Handbook Number 701). To the extent possible, this analysis would draw on existing landscape evaluations prepared by the Plumas National Forest and other land management agencies. The available data would be supplemented to the extent necessary by analysis of aerial photos and cartographic sources and highly targeted field observation and photo documentation.

- Plotting of the landscape data on GIS layers that would allow the data to be readily analyzed and readily related to other kinds of information. The viewsheds of major project facilities, reservoirs and stream channels could be defined using the GIS viewshed mapping system and the viewshed boundaries so delineated will be verified through selective field checking.

- Strong links could be made between the study plans for the aesthetics and the study plan for recreation. Data on recreational use patterns, and the perceptions of recreational users could be collected in a way that makes it useful for informing the selection of important viewing areas and the identification of aesthetic issues of concern to the area's recreational visitors.

6.0 REFERENCES

6.1 BIBLIOGRAPHY AND LITERATIURE CITED

Barter, E.R. 1987a. Maidu Collections of Dr. John W. Hudson from the Vicinity of Lake Oroville State Recreation Area. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Barter, E.R. 1987b. Sites Within the Boundaries of Lake Oroville State Recreation Area, Preliminary List, July 1987. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

BLM (Bureau of Land Management). 1993. Redding Resource Management Plan and Record of Decision. Redding, California.

Boyle, F.D. 1950. The Highway Magazine, May 1950: 117-118.

Brittan, Martin 1996. Spring 1996 vernal pool survey at Clay Pit State Vehicle Recreation Area. Prepared for California Department of Fish and Game by Michael Brandman Associates. Sacramento, California.

Brouha, P. and C.E. Von Geldern. 1979. Habitat manipulation for centrarchid production in western reservoirs. pp. 11-17 *in* D.L. Johnson and R.A. Stein, editors. Response of fish to habitat structure in standing water. North Central Division American Fisheries Society Special Publication 6.

Brown, A.M. 1997. California Waterfalls. San Francisco: Foghorn Press.

Bryan, C. Hobson. 1987. Socioeconomic Impacts of Red Man (Operation Bass) Tournaments: A Research Report. University of Alabama, Tuscaloosa.

Bureau of Economic Analysis. 2000. Personal Income and Per Capita Income by County, 1996-1998. Washington, DC: Bureau of Economic Analysis.

Butte County Historical Society. 1981. Application for Registration of Historical Landmark: Long's Bar. Office of Historic Preservation, Sacramento.

Butte County. 1996. Butte County General Plan. Oroville, California.

CALFED. 2000. Final Programmatic EIR/EIS. Sacramento, CA.

California Assembly. 1961. Chapter 137, Statutes of 1961, Assembly Concurrent Resolution No. 86, Relative to Curry-Bidwell Bar State Park.

California Department of Finance. 1990. Population Estimates for California Cities and Counties, January 1, 1981 to January 1, 1990. Report 90 E-4. Sacramento, CA: California Department of Finance.

California Department of Finance. 1998. County Population Projections with Race/Ethnic Detail. Sacramento, CA: California Department of Finance.

California Department of Finance. 2000. City/County Population and Housing Estimates, January 1, 2000. Sacramento, CA: California Department of Finance.

California Employment Development Department. 2000a. Monthly Civilian Labor Force Data for Counties. Average Annual 1999 (Revised), Not Seasonally Adjusted, 1999 Benchmark. Sacramento, CA: California Employment Development Department.

California Employment Development Department. 2000b. Butte County Labor Force Data for Sub-County Areas (Data Not Seasonally Adjusted), 1999 Benchmark. Sacramento, CA: California Employment Development Department.

California Employment Development Department. 2000c. Butte County Annual Average Labor Force and Industry Employment, March 1999 Benchmark. Sacramento, CA: California Employment Development Department.

California State University Chico. 2000. Website. http://www.csuchico.edu/pub/facts/#quickfacts. October 5, 2000.

CGAP. 2000. California Gap Analysis Project Home Page [web page]. Available from http://www.biogeog.ucsb.edu/projects/gap/gap_home.html via the internet. Accessed 2000 Nov. 20.

Chartkoff, J. and B.W. Ritter. 1966. A Preliminary Report on Archaeological Survey Work Done in the Oroville Reservoir Area, 1966. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

City of Oroville. 1995. City of Oroville General Plan. Adopted October 3, 1995. Oroville, California.

Cook, S.F. 1955. The Epidemic of 1830-1833 in California and Oregon. University of California Publication is American Archaeology and Ethnology 43(3).

Cramer, S.P. 1990. Contribution of Sacramento Basin Hatcheries to Ocean Catch and River Escapement of Fall Chinook Salmon. Prepared for CDWR. Cramer and Associates: 113. Corvallis, OR.

CVRWQCB (Central Valley Regional Water Quality Control Board). 1994. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region. Third Edition. California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. Sacramento, California.

CVRWQCB 2000. A Compilation of Water Quality Goals. California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. Sacramento, California.

Dean Runyan Associates. 2000. Travel Impacts by County, 1992-1998. Prepared for the California Division of Tourism, Sacramento, CA. Sacramento, CA: Dean Runyan Associates.

Department of Transportation. 1987. Caltrans Historic Highway Bridge Inventory. Engineering Service Center, Sacramento.

Dettman, D.H. and D.W. Kelley. 1987. The roles of Feather and Nimbus Salmon and Steelhead hatcheries and natural reproduction in supporting fall run Chinook salmon populations in the Sacramento River Basin. Prepared by D.W. Kelley &

Associates for the California Department of Water Resources. 105 pp. Sacramento, CA

DFG (California Department of Fish and Game). 1965. Oroville Wildlife Area Resource Management Plan. Sacramento, California.– ordered, confirm name

DFG. 1995. Draft Plant List for the Oroville Wildlife Management Area.

Division of Beaches and Parks. 1962. Disposition of Historical Objects at Curry-Bidwell Bar State Park, Butte County, California. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Dixon, Roland B. 1905. The Northern Maidu. Bulletin of the American Museum of Natural History 17(3):119-436.

DPR (California Department of Parks and Recreation). 1973a. Lake Oroville Resource Inventory. Cultural Heritage Division, Sacramento.

DPR. 1973b. Lake Oroville State Recreation Area Resource Management Plan and General Development Plan. Cultural Heritage Division, Sacramento.

DPR. 1992. Summary of Burial Collections. MS on file at the Cultural Heritage Division, Sacramento.

DPR. 1999. Index to Historic and Archeological Resources Owned by the California Department of Parks and Recreation. Cultural Heritage Division, Sacramento.

DPR. 2000a. Website. http://ohv.parks.ca.gov/claypit/cpohv556.htm. October 5, 2000.

DPR. 2000b. Website. http://wwwdwr.water.ca.gov/Lake _ Oroville/water.html. October 5, 2000.

DPR. 2001. Website. http://ohv.parks.ca.gov/claypit/cpohv556.htm. January 12, 2001.

Duncan, J. 1963. Maidu Ethnobotany. Master's thesis, California State University, Sacramento.

Duncan, J. and A.L. Smith. 1963. CA-BUT-199 Archeological Site Survey Record on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

DWR (California Department of Water Resources). 1969. Agreement on diversion of water from the Feather River. Department of Water Resources. Sacramento, California.

DWR. 1992. Proposed Study Plan for the Lower Feather River. Prepared for SWRCB, Sacramento, CA.

DWR. 1983. Concerning the operation of the Oroville Division of the State Water Project for management of fish and wildlife. Department of Water Resources. Sacramento, California.

DWR. 1993a. Program Environmental Impact Report. State Drought Water Bank. Sacramento: Department of Water Resources. p. 18

DWR. 1993b. Proposed Amended Recreation Plan for Lake Oroville State Recreation Area, Sacramento, California.

DWR. 1994. Factors affecting the distribution of chinook salmon on the lower Feather River, Sacramento. Environmental Services Office.

DWR. 1995. Lake Oroville Fisheries Habitat Improvement Plan. October.

DWR. 1997. Upper Feather River Lakes pamphlet.

DWR. 1999a. Assessment of MTBE in State Water Project Reservoirs. Memorandum Report. Division of Operations and Maintenance, Department of Water Resources. Sacramento, California.

DWR. 1999b. Lake Oroville State Recreation Areas pamphlet.

DWR. 1999c. Biological assessment: effects of the Central Valley Project and State Water Project operations from October 1998 through March 2000 on steelhead and spring-run Chinook salmon, pp. 211 and appendices.

DWR. 2000. Oroville Dam State Dam No. 1-40 Performance Report No. 10, January 1991 through July 2000, Department of Water Resources. Sacramento, California.

DWR. 2000a. Website. http://www.dwr.water.ca.gov/Lake_Oroville/home.html. October 5, 2000.

DWR. 2000b. 1999 Lake Oroville Annual Report of Fish Stocking and Fish Habitat Improvements, February.

DWR. 2001. Website. http://www.dwr.water.ca.gov/Lake_Oroville/home.html. January 12, 2001.

DWR and USBR (U.S. Bureau of Reclamation). 2000. Biological Assessment, Effects of the Central Valley Project and State Water Project Operations on Steelhead and Spring-run Salmon, Sacramento. November 2000.

Elsasser. A.B. 1960. The archaeology of the Sierra Nevada in California and Nevada. University of California Archaeological Survey Reports No. 51.

Elsasser, A.B. and F. VanZant. 1957. CA-BUT-69 Archeological Site Survey Record on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Engineering News-Record. 1946. Cables of 90-Year Old Bridge Still in Sound Condition. October 17, 1946: 106.

EPA (U.S. Environmental Protection Agency). 1973. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents. U.S. Environmental Protection Agency. Cincinnati, Ohio.

EPA. 1999. Nutrient criteria technical guidance manual: rivers and streams. Unpublished draft.

EPA. 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule. 40 CFR Part 131.

Forbes, K.L. 1989. An Ethnographic Study of the Contemporary Values of the Foothill Konkow, Butte County, California. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Furnis, C.L. and C. Young. 1976. Statewide Survey Project: Cultural Resources Project Survey, Lime Saddle, Lake Oroville. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Gebhardt, C. 1964. Archaeological Field Notes, Oroville Reservoir. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Green, F. 1996. Crossing the Feather to the City of Gold. *Diggins* 40:(2), 27-36. Butte County Historical Society, Oroville.

Gudde, E.G. 1969. California Place Names. University of California Press, Berkeley.

Guthrie, R. 1997. Lake Oroville State Recreation Area: Recreational use study. California State University Chico Foundation. Department of Recreation and Parks Management.

Guthrie, R.G., D.A. Penland, and E. Seagle. 1997. Lake Oroville State Recreation Area Recreational Use Study. Prepared for the California Department of Water Resources, Sacramento, CA. Chico, CA: CSU, Chico Foundation.

Hedgecock, D., Banks, M.A., Rashbrook, V.K., Dean, C.A., Blankenship, S.M. In Press. Applications of population genetic to conservation of Chinook salmon diversity in the Central Valley. Proceedings of the 1997 IEP Salmon Synmposium.

Healey, M.C. 1991. Life History of Chinook Salmon (*Oncorhynchus tshawytscha*). Pages 311-393 *in* C. Groot and L. Margolis, editors. Pacific Salmon Life Histories. UBC Press, Vancouver, B.C.

Hines, P.W. and E.R. Barter. 1986. Recommendations for Archaeological Sites in Lake Oroville State Recreation Area. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Hines, P.W. 1987. Lake Oroville State Recreation Area, Statewide Resources Management Plan, Project 118-151-81-1, 1986-1987. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Hines, P.W. 1996. A Partial Cultural Resource Survey of the Craig Saddle Area of Oroville State Recreation Area. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Hood, J.D. 1988. Archeological Survey Report, Lake Oroville State Recreation Area General Plan Amendment. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Hoover, M.S., H.E. Rensch, and E.G. Rensch. 1966. Historic Spots in California. Stanford: Stanford University Press.

Hunter, C.A. and R.I. Orlins. 2000. Cultural Resource Surveys for Lime Saddle Campground, Lime Saddle Marina Overflow Parking, and Nelson Cartop Boat Ramp Enhancement Project, Lake Oroville State Recreation Area, Butte County, California. MS on file at the Department of Water Resources, Division of Environmental Services, Sacramento.

Hunter, C.A., R.I. Orlins, and S.M. Atchley. 2000. Cultural Resource Survey for the Department of Water Resources Construction Debris Removal at the Feather River Fish Barrier Dam, Butte County, California. MS on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Jewell, D.P. 1964. Archeology of the Oroville Dam Spillway, Part 1. Department of Parks and Recreation Archeological Report 10.

Jensen and Associates. 1990. Archaeological Inventory Survey of Gold Beach Aviations' Proposed Land Split Project Involving Approximately 28 Acres Near Lime Saddle, Butte County, California. MS on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Jones and Stokes Associates. 1999a. Archaeological Survey Report for the Proposed Feather River Bikeway Extension Phase II, Oroville, Butte County, California. MS on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Jones and Stokes Associates. 1999b. Historic Resources Evaluation Report for the Proposed Feather River Bikeway Extension Phase II, Oroville, Butte County, California. MS on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Jones and Stokes Associates. 1999c. Historic Architectural Survey Report for the Proposed Feather River Bikeway Extension Phase II, Oroville, Butte County, California. MS on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Jones and Stokes Associates. 1999d. Request for Determination of Eligibility for Historic Archaeological Site Oroville-1, Oroville, Butte County, California. MS on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Kalenik, M. 1981. Lake Oroville State Recreation Area Resource Inventory Cultural Resource Update. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Kautz, R.R. 1988. Final Report of the Burial Inventory Project. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Kautz, R.R. and W. Taugher. 1987. Burial Inventory Project Final Report of Phase I Activities. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Kindopp, Jason E. 1999. Intragravel Egg Survival of Fall Run Chinook Salmon (Oncorhynchus thshawytscha) in the Lower Feather River, Butte County, California. MS Thesis. California State University, Chico, Chico, CA.

Kowta, Makota. 1988. The Archaeology and Prehistory of Plumas and Butte Counties, California; An Introduction and Interpretative Model. California Archaeological Site Inventory, Northeast Information Center, California State University, Chico.

Kroeber, Alfred L. 1925. Handbook of the Indians of California. Bureau of American Ethnology Bulletin 78. Washington, D.C.: Smithsonian Institution.

LNF (Lassen National Forest). 2000a. Website. PG&E's Campgrounds, fishing access and picnic areas. Website: http://www.r5.fs.fed.us/lassen/lake_almanor.htm. July 2000.

LNP. 2000b. Website. http://www.nps.gov/lavo/home.htm.October 5, 2000.

Longhurst, W.M. Garton, E. O., Heady, H.F., and G.E. Connolly. 1976. The California deer decline and possibilities for restoration. Ann. Meet. West. Sec. Wildlife Society (Fresno, CA) 1976:74-103.

Manning, J.P. 1998. Archaeological Investigations at CA-BUT-584. MS on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Mansfield, G.C. 1918. History of Butte County, California, with Biographical Sketches of the Leading Men and Women of the County Who Have Been Identified with Its Growth and Development from the Early Days to the Present. Historic Record Company, Los Angeles.

Markley, R.E. 1977. An Archaeological Reconnaissance of Two Alternative Locations for a New Feather River Bridge. MS on at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Markley, R.E. 1978. Archaeological Excavation in the Oroville Locality, Butte County, California. Master's thesis, California State University, Chico.

Mayer, K.E., and W.F. Laudenslayer Jr., eds. 1988. A guide to wildlife habitats in California. California Department of Fish and Game 166pp.

McAleer, J. 1977. History of Limekiln at BUT-392. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

McCarthy, H. 1998. Ethnography and Ethnohistory Pertaining to Craig Saddle Archaeological Sites, Lake Oroville. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

McGie, J. 1982. History of Butte County. Volume I, 1840-1919. Butte County Office of Education, Oroville, California.

Merriam, C.H. n.d.-a. California Journal, 1898-1939. MS on file at the Department of Anthropology, University of California, Davis.

Merriam, C.H. n.d-b. Ethnographic Notes, Midoo, 1898-1939. MS on file at the Bancroft Library, University of California, Berkeley.

Myrick et al., 1999. Growth and Thermal Biology of Feather River Steelhead Under Constant and Cyclical Temperatures. (Draft Report).

Nilsson, E.R. Berill, A. Huberland, and M.S. Kelly. 1995. Cultural Resources Inventory and Evaluation of 14,700 Acres on Beale Air Force Base, Yuba County, California. Prepared for United States Air Force, Beale Air Force Base, California.

Offerman, J. 1988. Negative Archaeological Survey Report of the Proposed Bridge Replacement of the Feather River on Highway 162. MS on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Offerman, J. and D. Noble. 1991. Negative Archaeological Survey Report of Improvements to Highway 162. MS on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Office of Historic Preservation. 2000a. Historic Properties Directory for Oroville.

Office of Historic Preservation. 2000b. Archeological Determinations of Eligibility, Butte County.

Olsen, W.H. 1963. CA-BUT-212 Archeological Site Survey Record on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Olsen, W.H. 1964. Archaeological Survey Program for the Oroville Reservoir. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Olsen, W.H. 1970. Archeological Resources of the Oroville Reservoir Area, Butte County, California. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Olsen, W.H. 1972. Extant Archeological Sites in the Oroville Reservoir and Preliminary Evaluation. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Olsen, W.H. and F.A. Riddell. 1963. The Archeology of the Western Pacific Railroad Relocation, Oroville Project, Butte County, California. Department of Parks and Recreation Archeological Report No. 7.

Olsen, W.H. and F.A. Riddell. 1968. Archaeological Inventory at the Konkow Village of Shilteamomahukuma (CA-BUT-182), Oroville Locality, California. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Orlins, R.I. 1997. Cultural Resources Survey for Oroville Field Division Recreation Plan, Lime Saddle Campground. MS on file at the Department of Water Resources, Division of Environmental Services, Sacramento.

Orlins, R.I. 1999. Cultural Resources Survey for the Reinforced Levee Notch Project, Oroville Wildlife Area, State Water Facilities, California Aqueduct, Butte County, California. MS on file at the Department of Water Resources, Division of Environmental Services, Sacramento.

Oroville Now. 2000. Website. http://now2000.com/oroville/info.shtml. October 5, 2000.

Painter, R.E., L.H. Wixom, and S.N. Taylor. 1977. An evaluation of fish populations and fisheries in the post-Oroville project Feather River. Sacramento. California Department of Fish and Game-Anadromous Fisheries Branch.

Palmer, L.L. 1962. CA-BUT-158 Archeological Site Survey Record on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

PG&E (Pacific Gas and Electric Company). 1997. Final Environmental Assessment for New License. Rock Creek-Cresta Hydroelectric Project. FERC No. 1962. Washington, DC.

PG&E. 2000. Website. http://wwwext01.pge.com/customer_services/other/rec_areas/p2. html. October 5, 2000.

Plumas County Visitor Bureau and Feather Publishing Co. 1998. Plumas County Northern California Visitor Guide. Quincy, CA.

PNF (Plumas National Forest). 1988. Land and Resource Management Plan. USDA Forest Service.

PNF. 2000. Website. Camping in the Plumas National Forest Website: http://r05s001.pswfs.gov/plumas/recr/camping/campmn.htm. July 14, 2000.

Powers, S. 1976 (orig. 1877). Tribes of California. Berkeley: University of California Press.

Reynolds, F.L., Mills, T.J., Benthin, R., Low, A. 1993. Restoring Central Valley Streams: A Plan for Action.

Riddell, F.A. 1960-1964. Archaeological Work Reports. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Riddell, F.A. 1975. CA-BUT-569 Archeological Site Survey Record. MS on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Riddell, F.A. 1978. Maidu and Konkow. In *California*, edited by R.F. Heizer, pp. 370-386. Handbook of North American Indians, vol. 8, W.C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

Ritter, E.W. 1965-1966. CA-BUT-21/H, -29, -30, -199, -249, -293, -396, -426, and -428 Archeological Site Survey Records on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Ritter, Eric W. 1968. Culture History of the "Tie Wah" (4-BUT-84) Oroville Locality, California. Master's thesis, University of California, Davis.

Ritter, Eric W. 1970. Northern Sierra Foothill Archaeology: Culture History and Culture Process. In Papers on California and Great Basin Prehistory, University of California, Center for Archaeological Research at Davis, Publication No. 2.

Ritter, E.W. and E.B. Parkman. 1992. Rock Art of the Foothills of the Northern Sierra Nevada-Southern Cascade Range Interface. American Indian Rock Art 18:81-104.

Ritter, E.W. and A.L. Smith. 1965. CA-BUT-158 and CA-BUT-392 Archeological Site Survey Records on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Rivers, B. 1990. Lake Oroville State Recreation Area, Craig Saddle Archaeological Site Rehabilitation. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Rivers, B. 1991. CA-BUT-20/H, -21/H, -1261, -1267, -1272, -1273, and -1300 Archeological Site Survey Records on file at the Northeast Information Center, Department of Anthropology, California State University, Chico.

Sampson, M. and J. McAleer. 1977. Archaeological and Historical Investigations of Lime Saddle (CA-BUT-392), Lake Oroville State Recreation Area. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Sawyer, John and Todd Keeler-Wolf, 1995. A Manual of California Vegetation. California Native Plant Society Press. 469p.

Schlising, Robert and Ellen Sanders. 1982. Quantitative analysis of vegetation at the Richvale vernal pools, California. American Journal of Botany 69: 734-742.

Snowden, J. 1984. The Bucks Mountain/Mooretown Deer Herds Management Plan. California Department of Fish and Game, Wildlife Management Branch Report. 100pp.

State Board of Equalization. 2000. Taxable Sales, by County and City, 1999. Sacramento, CA: State Board of Equalization.

Steidl, L., B. Walsh, and R. Benson. 1999. A Partial Archaeological Reconnaissance of the Craig Area, Lake Oroville State Recreation Area. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Stienstra, T. 1999. California Fishing: The complete guide to over 2,000 fishing spots on lakes, streams, rivers, and the coast, Foghorn Press, Santa Rosa, California.

Stienstra, T. 2000. California Recreational Lakes and Rivers Second Edition. Foghorn Outdoors, Avon Travel Publishing, Inc., Emeryville, California.

Stratton, George. 1991. Recreation Guide to California National Forests. Falcon Press Publishing Co. Helena, MT.

Swiden, S. 1986. California State Park System Archeological Site Inventory. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

SWRCB (State Water Resources Control Board). 1971. Water Quality Criteria, Second Edition. Sacramento, California.

Talbitzer, B. 1987. Butte County: An Illustrated History. Northridge: Windsor Publications, Inc.

Treganza, A.E. 1953. The Archaeological Resources of Seven Reservoir Sites in Central and Northern California. MS on file at the National Park Service, San Francisco.

United States Department of Agriculture Forest Service. 1995. Landscape Aesthetics: A Handbook for Scenery Management. Agriculture Handbook. Number 701.

USBR (U.S. Bureau of Reclamation). 1970. Central Valley Water Resource Study. Federal Water Pollution Control Administration and U.S. Bureau of Reclamation. San Francisco and Sacramento, California.

USBR. 1975. Central Valley Project, Operation, Total Water Management Study for the Central Valley Basin, California. U.S. Bureau of Reclamation, Mid-Pacific Region. Sacramento, California.

USGS. 1993. Water Resources Data, California, Water Year 1992. Volume 4. Northern Central Valley Basins and the Great Basin from Honey Lake Basin to Oregon State Line. U.S. Geological Survey. Sacramento, California.

Voegelin, E. 1992. Culture Element Distributions XX: Northeast California. University of California Anthropological Records 7(2).

Warne, W.E. 1965. Pioneer Cemetery. Address Presented at the Dedication of Pioneer Cemetery, Oroville Division of the State Water Project, May 2, 1965. MS on file at the Department of Parks and Recreation, Northern Service Center, Sacramento.

Webber, H.J. 1927. California's Oldest Orange Tree. Sunset Magazine. September 1927.

Wells, H.L. and W.L. Chambers. 1882. History of Butte County. San Francisco: H.L. Wells.

Welts, A. n.d. History Notes on Lake Oroville State Recreation Area. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

Wilson, N.L. and A. Towne. 1972. Selected Bibliography of Maidu Ethnography. MS on file at the National Park Service, San Francisco.

Woodward, J. 1984. Archeological Survey Report, Parish Camp Property Exchange. MS on file at the Department of Parks and Recreation, Cultural Heritage Division, Sacramento.

6.2 PERSONAL COMMUNICATIONS

Atkinson, Andy. September, 2000. California Department of Fish and Game, Wildlife Area Manager.

Lomeli, Henry. July 2000. California Department of Fish and Game, Butte County Wildlife Biologist.

Olsen, W.H. 13 April 2000. Assistant State Archeologist (ret.). DPR. Interview with Robert Orlins. DWR.

Robbins Ed. Department of Water Resources. 12 October 2000. Phone conversation with author.

This page was left blank intentionally.

APPENDICES

APPENDIX A
WATER QUALITY

WATER QUALITY GOALS AND CRITERIA

Several agencies adopt goals and criteria (Table A-1) for the protection of beneficial uses of water (CVRWQCB 2000). The U.S. Environmental Protection Agency (EPA) has primary authority to implement provisions of the federal Clean Water Act (CWA) and establishes guidance used by state and other agencies in developing criteria and goals for protection of aquatic resources, human health, and other beneficial uses. The CWA requires each Regional Water Quality Control Board (RWQCB) to develop a Water Quality Control Plan (Basin Plan) for waterbodies within each of their jurisdictions. Within the Central Valley of California, the Central Valley RWQCB adopts the Basin Plan containing water quality objectives to protect beneficial uses, which for the Feather River watershed include municipal and domestic supply, agriculture, industry (including electrical power production), recreation, freshwater habitat, and wildlife habitat (CVRWQCB 1994).

Field Parameters Goals and Criteria

Basin Plan objectives have been developed for several parameters usually measured in the field, including dissolved oxygen (DO), pH, conductivity, turbidity, and temperature. Maintenance of specific water temperatures at the Feather River Fish Hatchery is required in an agreement with the DF&G. Another agreement with several water districts also contains temperature provisions for water diverted for irrigation.

Dissolved oxygen objectives of the Basin Plan that apply to all water bodies require a minimum level of 5.0 mg/L for waters designated as warm freshwater habitat, and 7.0 mg/L for cold freshwater habitat and spawning habitat. In addition, a minimum of 8.0 mg/L of DO is required from September 1 to May 31 in the Feather River from the Fish Barrier Dam at Oroville to Honcut Creek.

The Basin Plan stipulates that pH “shall not be depressed below 6.5 nor raised above 8.5.” In addition, “changes in normal ambient pH levels shall not exceed 0.5 in fresh waters with designated” cold or warmwater habitat beneficial uses.

Table A-1 Water quality goals (ug/L) (CVRWQCB 2000)

Parameter	RWQCB Basin Plan Objectives	U.S. EPA or California DHS Drinking Water Maximum Contaminant Level		Agricultural Goal	USEPA California Toxics Rule Criteria for Freshwater Aquatic Life for Dissolved Metals		USEPA National Toxics Rule Criteria for Freshwater Aquatic Life for Total Recoverable Metals		USEPA National Ambient Water Quality Criteria Freshwater Aquatic Life Protection	
		Primary	Secondary		Dissolved Continuous Conc. (4 day average)	Dissolved Maximum Conc. (1 hour average)	Total Continuous Conc. (4 day average)	Total Maximum Conc. (1 hour average)	Continuous Conc. (4 day average)	Maximum Conc. (1 hour average)
Aluminum		1000	200	5000					87	750
Ammonia		1500							[1]	[1]
Arsenic	10 [2]	50		100	150	340	190	360	190 [2]	360 [2]
Asbestos		7 MFL [3]								
ASAR				<3						
Barium	100 [2]	1000								
Boron				700						
Cadmium	0.22 [2]	5		10	2.2 [4]	4.3 [4]	1.1 [4]	3.9 [4]	[2,4]	[2,4]
Chloride			500,000	106,000						
Chromium		50 (total)		100 (Cr IV)	11	16	11	16	10	15
Conductivity			1,600	700						
Copper	5.6 [2]	1,300	1,000	200	9 [4]	13 [4]	12 [4]	18 [4]	[2,4]	[2,4]
Iron	300 [2]		300	5,000						1,000
Lead		15		5,000	[4]	[4]	3.2 [4]	82 [4]	[2,4]	[2,4]
Manganese	50 [2]		50	200						
Mercury		2				0.051	0.012	2.4	0.012 [5]	2.1 [2]
Molybdenum				10						
Nickel		100		200	52 [4]	470 [4]	160 [4]	1400 [4]	[2,4]	[2,4]
Nitrate (as N)		10								
pH	6.5 - 8.5		6.5 - 8.5							
Selenium		50		20	5 [5]	20 [5]	5	20	5 [5]	20 [5]
Silver	10 [2]		100		[4]	[4]		4.1	0.19 [2]	[2,4]
Zinc	16 [2]		5,000	2,000	120 [4]	120 [4]	110	120	[4]	[4]

Footnotes:
1. pH and temperature dependent
2. As dissolved
3. Million fibers per liter longer than 10 microns
4. Hardness dependent; criterion indicated based on hardness of 100 mg/L
5. As total recoverable

The objective in the Basin Plan for electrical conductivity for the North and Middle Forks of the Feather River and the Feather River downstream from Oroville Dam is a maximum of 150 μmhos/cm.

Numerical goals or criteria have not been established for natural turbidity levels. The Basin Plan specifies that "waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses." For controllable factors, allowable increases in turbidity are no more than 1 nephelometric turbidity unit (NTU) where natural turbidity ranges between 0 and 5 NTUs; 20 percent where natural turbidity ranges between 5 and 50 NTUs; 10 NTUs where natural turbidity ranges between 50 and 100 NTUs; and 10 percent where natural turbidity exceeds 100 NTUs.

Unless demonstrated that beneficial uses are not adversely affected, the Basin Plan requires that water temperatures of warm and cold freshwater habitat not be increased by more than 5ºF by controllable factors.

An agreement in 1983 between the DWR and DFG specifies water temperature requirements for the Feather River Fish Hatchery (DWR 1983). Water temperatures of the water supply for the hatchery must be maintained at 51°F from April 1 to May 15; 55°F from May 16 to 31; 56°F from June 1 to 15; 60°F from June 16 to August 15; 58°F from August 16 to 31; 52°F from September 1 to 30; 51°F from October 1 to November 30; and no greater than 55°F from December 1 to March 31. A temperature deviation of four degrees is allowed between April 1 and November 30. In addition, the agreement contains an objective for provision of suitable temperatures for fall-run salmon not later than September 15 below the Thermalito Diversion Dam and Thermalito Afterbay river outlet, as well as for shad, striped bass, and other warmwater fish between May 1 and September 1 below the Afterbay Outlet.

Several water districts in the Feather River watershed diverted water from the Feather River prior to construction of Oroville Dam. The Department entered into agreements with certain water districts to provide them water based upon prior rights. These agreements generally do not have specific requirements for water quality. The agreement among Richdale Irrigation District, Biggs-West Gridley Water District, Butte Water District, Sutter Extension Water District, and the Department includes terms describing amounts of water that the State shall make available to the districts. That agreement, however, provides that the State is not relieved of any liability for damages that may arise from harm to crops due to reduction in temperatures of water available to the districts during the agricultural season as a result of water being colder than would have occurred if Oroville Dam had not been constructed (State of California, The Resources Agency, Department of Water Resources Agreement on Diversion of Water from the Feather River [May 27, 1969]). That agreement does not determine what temperature would in fact cause injury to crops. Local rice farmers in the area, as stated earlier in this document, assert a need for water of about 65° F from April through mid-May and 59° F during the remainder of the growing season.

Nutrient Goals and Criteria

The primary interest in nutrient concentrations in natural waters concerns stimulation of excessive growths of algae and macrophytes. The Basin Plan states that "water shall not contain biostimulatory substances which promote aquatic growths in concentrations that cause nuisance or adversely affect beneficial uses." However, numerical criteria for nutrients have not been established.

The EPA is currently attempting to develop nutrient criteria and has published a draft guidance manual for rivers and streams (EPA 1999). Various studies cited in the guidance manual suggest that total phosphorus concentrations greater than 0.1 to 0.2 mg/L may stimulate undesirable growths of algae .

Ammonia at sufficient concentration has been found to be deleterious to aquatic life. In response, the EPA published criteria for continuous and maximum allowable ammonia levels for the protection of freshwater aquatic life (CVRWQCB 2000). These criteria are based on water pH and temperature.

Mineral Goals and Criteria

Minerals are naturally found in waters, generally at concentrations that do not produce adverse effects. However, low concentrations of minerals increase the toxicity of metals and the corrosiveness of water. Conversely, high concentrations of minerals can cause increased soap consumption in domestic use, staining of laundry fixtures, scale formation in industrial applications, and adverse effects to crops and soils.

While the Basin Plan states that "waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses," specific criteria for most minerals have not been formulated. However, electrical conductivity, for which goals have been established, is indicative of the mineral concentration of water and can be used to determine general mineral quality.

The Basin Plan contains an objective for boron that is only applicable to the San Joaquin River watershed. However, the Food and Agriculture Organization of the United Nations established a goal of a maximum concentration of boron in irrigation water of 0.7 mg/L for protection of crops (CVRWQCB 2000).

The U.S. Department of Agriculture developed a classification for irrigation water to maintain tilth and structure of soil based on concentrations of sodium, calcium, magnesium, and potassium (SWRCB 1971). This classification scheme uses concentrations of these minerals to calculate an adjusted sodium adsorption ratio. Ratios less than 6.0 indicate no problems with agricultural use of the water, while higher ratios indicate increasing problems.

Metals Goals and Criteria

Metals in the aquatic environment are a concern due to direct toxicity to aquatic life and other beneficial uses. Several agencies have adopted criteria addressing effects of metals to beneficial uses (CVRWQCB 2000).

The California Department of Health Services (DHS) is responsible for adopting criteria for the protection of drinking water. These standards are required to be at least as stringent as those adopted by the EPA. DHS has adopted maximum contaminant levels (MCLs) for several metals as part of the drinking water standards.

Criteria for protection of crops from metals toxicity have not been developed. However, agricultural goals have been published by the Food and Agriculture Organization of the United Nations to protect agricultural uses of water.

The EPA established National Ambient Water Quality Criteria to protect human health and welfare and freshwater and marine aquatic life from pollutants, including metals, in surface water. These criteria were last updated in 1986.

In December 1992, the EPA adopted the National Toxics Rule, which updated many of the earlier criteria. This rule required water quality samples to be analyzed for total recoverable concentrations of metals to determine compliance with the aquatic life protective criteria. Many of the aquatic life criteria were converted to dissolved concentrations in an amendment by the EPA in 1995.

Legal challenge resulted in repeal of the State Water Resources Control Board's Inland Surface Waters Plan and Enclosed Bays and Estuaries Plan. Therefore, the EPA proposed and subsequently adopted on May 18, 2000 water quality criteria (known as the California Toxics Rule [CTR]) for priority toxic pollutants for California's inland surface waters and enclosed bays and estuaries (EPA 2000). The CTR establishes criteria for total mercury and the dissolved fraction of other metals.

Biological Monitoring Goals and Criteria

Monitoring of biological organisms is increasingly being used as an indicator of water quality. Benthic macroinvertebrates comprise a large group of insect and other bottom-dwelling organisms that are naturally present in surface water bodies. The types of macroinvertebrates present reflect the water quality history. Certain types of organisms are less tolerant than others of various types of perturbations. Perturbations generally result in elimination or severe reduction in numbers of individuals or species of intolerant organisms and development of large populations of tolerant species due to lack of competition or predation. In relatively undisturbed environments, communities are composed of large numbers of species with no individual species present in overwhelming abundance.

The Basin Plan states that "the survival of aquatic life in surface waters subjected to a waste discharge or other controllable water quality factors shall not be less than that for the same water body in areas unaffected by the waste discharge." Numerical criteria for benthic macroinvertebrate communities have not been developed. However, numerous indices are available for evaluating benthic macroinvertebrate community data. One of the earliest and perhaps most applicable indices is the diversity index (EPA 1973). This index uses the richness of species and distribution of individuals among the species to determine aquatic health. The calculated species diversity can be compared to a hypothetical maximum diversity to measure the distribution of individuals among the species, or equitability. Application of these indices to benthic macroinvertebrate data from a variety of sources has shown that diversity in unpolluted water generally ranges between three and 4, whereas in polluted water the diversity is generally less than 1. Equitability values generally ranges between 0.6 to 0.8 in streams without degradation, but even slight levels of degradation reduces equitability generally to a range between 0.0 and 0.3.

APPENDIX B
WILDLIFE SPECIES OCCURRENCE IN BUTTE COUNTY

Amphibians

COMMON NAME	SCIENTIFIC NAME
Bullfrog	*Rana catesbeiana*
California newt	*Taricha torosa*
California slender salamander	*Batachoseps attenuatus*
California tiger salamander	*Ambystoma tigrinum*
Ensatina	*Ensatina eschschltzi*
foothill yellow-legged frog	*Rana boylei*
long-toed salamander	*Ambystoma macrodactylum*
mountain yellow-legged frog	*Rana muscosa*
Pacific chorus frog	*Hyla regilla*
red-legged frog	*Rana aurora*
rough-skinned newt	*Taricha granulosa*
western spadefoot	*Scaphiopus hammondi*
western toad	*Bufo boreas*

Reptiles

COMMON NAME	SCIENTIFIC NAME
California mountain kingsnake	*Lampropeltis zonata*
California whipsnake	*Masticophis lateralis*
Coachwhip	*Masticophis*
Coast horned lizard	*Phrynosoma coronatum*
common garter snake	*Thamnophis sirtalis*
common kingsnake	*Lampropeltis getulus*
Gilberts skink	*Eumeces gilberti*
gopher snake	*Pituophis melanoleucus*
night snake	*Hypsigiena torquata*
northern alligator lizard	*Gerrhonotus coeruleus*
Racer	*Coluber constrictor*
ringneck snake	*Diadophis punctatus*
rubber boa	*Charina bottae*
sagebrush lizard	*Sceloporus graciosus*
sharp-tailed snake	*Contia tenuis*
southern alligator lizard	*Gerrhonotus multicarinatus*
western aquatic garter snake	*Thamnophis couchi*

western fence lizard	*Sceloporus occidentalis*
western pond turtle	*Clemmys marmorata*
western rattle snake	*Crotalis viridis*
western skink	*Eumeces skiltonianus*
western terrestrial garter snake	*Thamnophis elegans*
western whiptail	*Cnemidophorus tigris*
Birds	
acorn woodpecker	*Melanerpes formicivorus*
American avocet	*Recurvirostra americana*
American bittern	*Botaurus lentiginosus*
American coot	*Fulica americana*
American crow	*Corvus brachyrhynchos*
American dipper	*Cinculus mexicanus*
American goldfinch	*Carduelis tristis*
American kestrel	*Falco sparverius*
American pipit	*Anthus rubescens*
American robin	*Turdus migratorius*
American white pelican	*Pelecanus erythrorhynchos*
American widgeon	*Anas americana*
Anna's hummingbird	*Calypte anna*
ash-throated flycatcher	*Myiarchus cinerascens*
bald eagle	*Haliaeetus leucocephalus*
band-tailed pigeon	*Columba fasciata*
bank swallow	*Riparia riparia*
barn owl	*Tyto alba*
barn swallow	*Hirundo rustica*
Barrow's goldeneye	*Bucephala islandica*
belted kingfisher	*Ceryle alcyon*
Bewick's wren	*Thryomanes bewickii*
black phoebe	*Sayornis nigricans*
black swift	*Cypesloides niger*
black tern	*Chlidonias niger*
black-backed woodpecker	*Picoides arcticus*
black-chinned hummingbird	*Archilochus alexandri*
black-chinned sparrow	*Spizella atrogularis*
black-crowned night heron	*Nycticorax nycticorax*

black-headed grosbeak	*Pheucticus melanocephalus*
black-necked stilt	*Himantopus mexicanus*
black-throated gray warbler	*Dendroica nigrescens*
black-throated sparrow	*Amphispiza bilineata*
blue grosbeak	*Guiraca caerulea*
blue grouse	*Dendragapus obscurus*
blue-gray knatcatcher	*Polioptilla caerulea*
blue-winged teal	*Anas discors*
Brewer's blackbird	*Euphagus cyanocephalus*
brown creeper	*Certhia americana*
brown-headed cowbird	*Molothus ater*
bufflehead	*Bucephala albeola*
burrowing owl	*Athene cunicularia*
bushtit	*Psaltriparus minimus*
California gull	*Larus californicus*
California quail	*Callipepla californica*
California thrasher	*Toxostoma redivivum*
California towhee	*Pipilo crissalis*
calliope hummingbird	*Stellula calliope*
Canada goose	*Branta canadensis*
canvasback	*Aythya valisineria*
canyon wren	*Catherpes mexicanus*
Cassin's finch	*Carpodacus cassinii*
cattle egret	*Bubulcus ibis*
cedar waxwing	*Bombycilla cedrorum*
chestnut-backed chickadee	*Parus refescens*
chipping sparrow	*Spizella passerina*
cinnamon teal	*Anas cyanoptera*
Clark's grebe	*Aechmophorus clarkii*
cliff swallow	*Hirundo pyrrhonota*
common goldeneye	*Bucephala clangula*
common loon	*Gavia immer*
common merganser	*Mergus merganser*
common moorhead	*Gallinula chloropus*
common nighthawk	*Chordeiles minor*
common poorwill	*Phalaenoptilis nuttallii*

common raven	*Corvus corax*
common snipe	*Gallinago gallinago*
common yellowthroat	*Geothlypis trichas*
Cooper's hawk	*Accipiter cooperii*
dark-eyed junco	*Junco hyemalis*
double-crested cormorant	*Phalacrocorax auritus*
downy woodpecker	*Picoides pubescens*
dunlin	*Calidris alpina*
dusky flycatcher	*Empidonax oberholseri*
eared grebe	*Podiceps nigricollis*
eurasian widgeon	*Anas penelope*
European starling	*Sturnus vulgaris*
evening grosbeak	*Coccothraustes vespertinus*
ferruginous hawk	*Buteo regalis*
flammulated owl	*Otus flammeolus*
Forester's tern	*Sterna forsteri*
fox sparrow	*Passerella iliaca*
glaucous-winged gull	*Larus glaucescens*
golden eagle	*Aquila chrysaetos*
golden-crowned kinglet	*Regulus satrapa*
golden-crowned sparrow	*Zonotrichia atricapilla*
great blue heron	*Ardea herodias*
great egret	*Casmerodius albus*
great horned owl	*Bubo virginianus*
greater roadrunner	*Geococcyx californianus*
greater scaup	*Aythya marila*
greater white-fronted goose	*Anser albifrons*
greater yellowlegs	*Tringa melanoleuca*
green-backed heron	*Butorides striatus*
green-tailed towhee	*Pipilo chlorurus*
green-winged teal	*Anas crecca*
hairy woodpecker	*Picoides villosus*
Hammond's flycatcher	*Empidonax hammondii*
hermit thrush	*Catharus guttatus*
hermit warbler	*Dendroica coccidentalis*
herring gull	*Larus argentatus*

hooded merganser	*Lophodytes cucullatus*
hooded oriole	*Icterus cucullatus*
horned lark	*Eremophila alpestris*
house finch	*Carpodacus mexicanus*
house sparrow	*Passer domesticus*
house wren	*Troglodytes aedon*
Hutton's vireo	*Vireo huttoni*
killdeer	*Charadrius vociferus*
lapland longspur	*Calcarius lapponicus*
lark sparrow	*Chondestes grammacus*
Lawrence's goldfinch	*Carduelis lawrencei*
lazuli bunting	*Passerina amoena*
least bittern	*Ixobrychus exilis*
least sandpiper	*Calidris minutilla*
lesser goldfinch	*Carduelis psaltria*
lesser nighthawk	*Chordeiles acutipennis*
lesser scaup	*Aythya affinis*
Lewis' woodpecker	*Melanerpes lewis*
Lincoln's sparrow	*Melospiza lincolnii*
loggerhead shrike	*Lanius ludovicianus*
long-billed curlew	*Numenius americanus*
long-billed dowitcher	*Limnodromus scolopaceus*
long-eared owl	*Asio otus*
MacGillivray's warbler	*Oporonis tolmiei*
mallard	*Anas platyrhynchos*
marsh wren	*Cistothorus palustris*
merlin	*Falco columbarius*
mew gull	*Larus canus*
mountain bluebird	*Sialia currucoides*
mountain chickadee	*Parus gambeli*
mountain quail	*Oreortyx pictus*
mourning dove	*Zenaida macroura*
Nashville warbler	*Vermivora ruficapilla*
northen rough-winged swallow	*Stelgidopteryx serropennis*
northern flicker	*Colaptes auratus*
northern goshawk	*Accipiter gentilis*

northern harrier	*Circus cyaneus*
northern mockingbird	*Mimus polyglottos*
northern oriole	*Icterus galbula*
northern pintail	*Anas acuta*
northern pygmy-owl	*Glaucidium gnoma*
northern saw-whet owl	*Aegolius acadicus*
northern shoveler	*Anas clypeata*
northern shrike	*Lanius excubitor*
Nuttall's woodpecker	*Picoides nuttallii*
oak titmouse	*Parus inornatus*
olive-sided flycatcher	*Contopus borealis*
orange-crowned warbler	*Vermivora celata*
osprey	*Pandion haliaetus*
Pacific-slope flycatcher	*Empidonax difficilis*
peregrine falcon	*Falco peregrinus*
phainopepla	*phainopepla nitens*
pied-billed grebe	*Podilymbus podiceps*
pileated woodpecker	*Dryocopus pileatus*
pine siskin	*Carduelis pinus*
prairie falcon	*Falco mexicanus*
purple finch	*Carpodacus purpureus*
purple martin	*Progne subis*
red crossbill	*Loxia curvirostra*
red-breasted nuthatch	*Sitta canadensis*
red-breasted sapsucker	*Sphyrapicus ruber*
red-shouldered hawk	*Buteo lineatus*
red-tailed hawk	*Buteo jamaicensis*
red-winged blackbird	*Agelaius phoeniceus*
redhead	*Aythya americana*
ring-billed gull	*Larus delawarensis*
ring-necked duck	*Aythya collaris*
ring-necked pheasant	*Phasianus colochicus*
rock dove	*Columba livia*
rock wren	*Salpinctes obsoletus*
Ross' goose	*Chen rossii*
rough-legged hawk	*Buteo lagopus*

ruby-crowned kinglet	*Regulus calendula*
ruddy duck	*Oxyura jamaicensis*
rufous-crowned sparrow	*Aimophila ruficeps*
rufous-sided towhee	*Pipilo erythrophthalmus*
sandhill crane	*Grus canadensis*
savannah sparrow	*Passerculus sandwichensis*
Say's phoebe	*Sayornis saya*
scrub jay	*Aphelocoma coerulescens*
sharp-shinned hawk	*Accipiter striatus*
short-eared owl	*Asio flammeus*
snow goose	*Chen caerulescens*
snowy egret	*Egretta thula*
solitary vireo	*Vireo solitarius*
song sparrow	*Melospiza melodia*
Sora	*Porzana carolina*
spotted owl	*Strix occidentalis*
spotted sandpiper	*Actitis macularia*
Stellar's jay	*Cyanocitta stelleri*
Swainson's hawk	*Buteo swansoni*
Swainson's thrush	*Catharus ustulatus*
Thayer's gull	*Larus thayeri*
Townsens's solataire	*Myadestes townsendi*
tree swallow	*Tachycineta bicolor*
tricolored blackbird	*Agelaius tricolor*
tundra swan	*Cygnus columbianus*
turkey vulture	*Cathartes aura*
varied thrush	*Ixoreus naevius*
Vaux's swift	*Chaetura vauxi*
violet-green swallow	*Tachycineta thalassina*
Virginia rail	*Rallus limicola*
warbling vireo	*Vireo gilvus*
western bluebird	*Sialia mexicana*
western grebe	*Aechmophorus occidentalis*
western kingbird	*Tyrannus verticalis*
western meadowlark	*Sturnella neglecta*
western sandpiper	*Calidris mauri*

western screech owl	*Otus kennicottii*
western tananger	*Piranga ludoviciana*
western wood pewee	*Contopus sordidulus*
white-breasted nuthatch	*Sitta carolinensis*
white-crowned sparrow	*Zonotrichia leucophrys*
white-faced ibis	*Plegadis chihi*
white-headed woodpecker	*Picoides albolarvatus*
white-tailed kite	*Elanus caeruleus*
white-throated swift	*Aeronautes saxatalis*
wild turkey	*Meleagris gallopavo*
Williamson's sapsucker	*Sphyrapicus thyroideus*
willow flycatcher	*Empidonax traillii*
Wilson's warbler	*Wilsonia pusilla*
winter wren	*Troglodytes troglodytes*
wood duck	*Aix sponsa*
wrentit	*Chamaea fasciata*
yellow warbler	*Dendroica petechia*
yellow-billed cuckoo	*Coccyzus americanus*
yellow-billed magpie	*Pica nuttalli*
yellow-breasted chat	*Ictervia virens*
yellow-headed blackbird	*Xanthocephalus xanthocephalus*
yellow-rumped warbler	*Dendroica coronata*
Mammals	
badger	*Taxidea taxus*
beaver	*Castor candensis*
Belding's ground squirrel	*Spermophilus beldingi*
big brown bat	*Eptesicus fuscus*
black bear	*Ursus americanus*
black rat	*Rattus rattus*
black-tailed hare	*Lepus californicus*
bobcat	*Felis rufus*
Botta's pocket gopher	*Thomomys bottae*
Brazilian free-tailed bat	*Tadarida brasiliensis*
broad-footed mole	*Scapanus latimanus*
brush mouse	*Peromyscus boylii*
brush rabbit	*Sylvilagus bachmani*

California ground squirrel	*Spermophilus beecheyi*
California kngaroo rat	*Dipodomys californicus*
California myotis	*Myotis californicus*
California vole	*Microtus californicus*
coyote	*Canis latrans*
deer mouse	*Permyscus maniculatus*
desert cottontail	*Sylvilagus audubonii*
Douglas' squirrel	*Tamiasciurus douglasii*
dusky-footed woodrat	*Neotoma fuscipes*
ermine	*Mustela erminea*
fisher	*Martes pennanti*
fringed myotis	*Myotis thysanodes*
golden-mantled ground squirrel	*Spermophilus lateralis*
grat fox	*Urocyon cinereoargentus*
hoary bat	*Lasiurus cinereus*
house mouse	*Mus musculus*
little brown myotis	*Myotis lucifugus*
long-eared myotis	*Myotis evotis*
long-legged myotis	*Myotis volans*
long-tailed vole	*Microtus longicaudus*
long-tailed weasel	*Mustela frenata*
marten	*Martes americana*
mink	*Mustela vison*
montane vole	*Mictotus montanus*
mountain lion	*Felis concolor*
mountain pocket gopher	*Thomomys monticola*
mule deer	*Odocoileus hemionus*
muskrat	*Ondatra zibethicus*
northern flying squirrel	*Glaucomys sabrinus*
Norway rat	*Rattus norvegicus*
pallid bat	*Antrozous pallidus*
pinyon mouse	*Peromyscus truei*
porcupine	*Erethizon dorsatum*
raccoon	*Procyon lotor*
red bat	*Lasiurus borealis*
red fox	*Vulpes vulpes*

ringtail	*Bassariscus astutus*
river otter	*Lutra canadensis*
silver-haired bat	*Lasionycteris noctivagans*
small-footed myotis	*Myotis leibii*
striped skunk	*Mephitis mephitis*
Townsend's big-eared bat	*Plecotus townsendii*
Trowbridge's shrew	*Sorex trowbridgii*
Virginia opossum	*Didelphis virginiana*
water shrew	*Sorex palustris*
western gray squirrel	*Sciurus griseus*
western harvest mouse	*Riethrodontomys megalotis*
western pipistrelle	*Pipistrellus hesperus*
western spotted skunk	*Spilogale gracilis*
wild pig	*Sus scrofa*
Yuma myotis	*Myotis yumanensis*